PB90-220633

Superfund Record of Decision (EPA Region 6)
Hardage/Criner Site, McClain County, Oklahoma
(First Remedial Action, Amendment), November 1989

(U.S.) Environmental Protection Agency, Washington, DC

22 Nov 89

U.S. Department of Commerce
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16. Abstract (Limit: 200 words)

The Hardage/Criner site is in an agricultural area near Criner, McClain County, in central Oklahoma. The site is situated in the North Criner Creek drainage basin, approximately 0.8 miles from the confluence of North Criner Creek and Criner Creek. From 1972 to 1980 the site was operated under a State permit for the disposal of industrial wastes including paint sludges and solids, ink solvents, tire manufacturing wastes, oils, other solvents, cyanides, and plating wastes sludges. Waste disposal practices have resulted in the contamination of approximately 70 acres of ground water beneath and adjacent to the site as well as several acres of surface soil. The principal source of contamination is approximately 278,000 cubic yards of sludges, waste drums, highly contaminated soil, and waste liquids contained in three main waste (source) areas near the center of the property. Additional source areas include scattered mixing ponds, spill areas, and runoff paths in the vicinity of the main source areas. Dense non-aqueous phase liquids have pooled beneath the disposal areas and are a continuing source of contamination to the ground water. A 1986 Record of Decision addressed source control through incineration, stabilization, and onsite disposal; however, the remedial action was never implemented due to protracted litigation. The 1989 ROD Amendment provides a comprehensive site remedy addressing both source control and ground water remediation and takes into consideration recently enacted land disposal restrictions. The primary contaminants of concern affecting soil, debris, (Continued on next page)

17. Document Analysis a. Descriptors
Record of Decision -Hardage/Criner, OK
First Remedial Action (Amendment)
Contaminated Media: soil, gw
Key Contaminants: VOCs (benzene, PCBs, PCE, TCE), other organics (pesticides), metals (arsenic, chromium, lead)

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement

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20. Security Class (This Page) None

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Agency

Office of
Emergency and
Remedial Response

EPA/ROD/R06-90/054
November 1989

EPA

Superfund Record of Decision:

Hardage/Criner, OK

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SPRINGFIELD, VA. 22161

16. Abstract (Continued)

and ground water are VOCs including benzene, PCBs, PCE, TCE and other carcinogenic compounds; other organics including pesticides; and metals including arsenic, chromium, and lead.

The selected remedial action for the site includes source control and ground water components. Source control remediation includes installation of liquid extraction wells to pump out free liquids currently pooled in the three waste areas and any liquids released from drums buried in the mounds, followed by offsite treatment of the removed organic liquids and onsite treatment of aqueous liquids; excavation of drummed organic liquids for offsite destruction; excavation and consolidation of contaminated soil adjacent to the main source areas with placement in the main source areas, followed by temporary capping; treatment of the main source areas using in-situ soil vapor extraction with treatment of air used in soil extraction by thermal destruction; installation of a permanent RCRA-compliant cap once remedial activities are complete. Ground water components are designed to control the spread of ground water plumes and protect downgradient areas because of the technical impracticability of restoration of the bedrock aquifer. Ground water remediation includes installation of an interceptor trench downgradient of the source areas to intercept and collect contaminated ground water migrating in bedrock zones, and a second trench or equally effective system of extraction wells to intercept and collect contaminated ground water contaminating the alluvium; design and construction of an onsite ground water treatment system to treat both organic and inorganic contaminants before discharge of treated water to surface water. Contaminants already present in the alluvium will be allowed to dissipate by natural dilution, natural attenuation, and flushing; however, active restoration will be implemented if contaminant reduction goals are not met. In addition, institutional controls, surface water controls, and multimedia monitoring will be implemented, and the current provision of an alternate water supply will be continued. The estimated present worth cost of this remedial action is $62,904,655, which includes an annual O&M cost of $1,300,000.

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RECORD OF DECISION AMENDMENT
HARDAGE/CRINER SITE
McCLAIN COUNTY, OKLAHOMA
NOVEMBER 1989

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION 6, DALLAS, TEXAS

1.C

DECLARATION
FOR THE
RECORD OF DECISION AMENDMENT

SITE NAME AND LOCATION

Hardage/Criner
McClain County, Oklahoma

STATEMENT OF BASIS AND PURPOSE

This decision document represents the selected remedial action for the Hardage/Criner site developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

This decision is based on the contents of the administrative record for the Hardage/Criner site. The attached index (Appendix C) identifies the items which comprise the administrative record upon which the decision to amend the 1986 Record of Decision (ROD), and the selection of the modified remedial action is based.

The State of Oklahoma supports a number of the components of the amendment but has not concurred with all elements of the selected remedial action.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from the site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE REMEDY

The 1989 proposed remedy is a comprehensive site remedy addressing both Source Control and Groundwater operable units at the Hardage/Criner site. It involves a modification of the 1986 ROD for Source Control, and incorporates new Groundwater response actions. The major components of this remedial action consist of the following source control and groundwater components:

SOURCE CONTROL

o the installation of liquid extraction wells in three main source areas to pump out free liquids currently pooled in these areas and any liquids released from drums buried in the mounds. The liquids would be collected and shipped offsite for treatment, thereby permanently reducing the volume of hazardous substances in the source areas and the potential for their migration.

- excavation as per the 1986 ROD for the direct removal of drummed liquids in the Barrel Mound and Main Pit. Drum excavation and liquids removal would reduce the volume of hazardous liquids within the source areas during the early phases of remedy implementation, thereby reducing the reliance on long-term active controls otherwise necessary to address the continued release and migration of hazardous liquids, many of which are highly toxic, resulting from gradual and difficult to predict corrosion of drums.
- excavation of contaminated soils in areas adjacent to the three main source areas and transport to the source areas. These materials would be consolidated under a temporary cap in the main source areas where they would be treated using soil vapor extraction.
- use of soil vapor extraction to draw air through the source areas after consolidation to evaporate contaminants and permanently remove them to the surface through air extraction wells. The air would be treated to destroy the contaminants using the best available control technology (BACT) by thermal destruction.
- permanent source area capping once remediation activities are complete. A temporary cap will be installed during remediation activities, followed by a permanent RCRA-compliant cap at the end of remediation.

GROUNDWATER

Groundwater components summarized below would be implemented in conjunction with a substantial reduction of the contaminant source areas thereby reducing the long-term potential contribution of the sources to groundwater.

- the installation of a V-shaped trench located downgradient (west, south and east) of the three main source areas to intercept and collect contaminated groundwater migrating in all bedrock zones existing above Stratum IV. This trench would capture contaminated groundwater onsite and near the source areas minimizing migration of contaminants beyond the trench and into the alluvium of North Criner Creek.
- the installation of an interceptor trench, or equally effective system of extraction wells, in the southwestern part of the site to contain contaminated groundwater moving into the alluvium from bedrock zones above Stratum IV. This interceptor system would capture migrating contaminants between the V-trench and alluvium of North Criner Creek.
- the design and construction of an onsite groundwater treatment system incorporating treatment processes to treat both organic and inorganic contaminants to surface water discharge standards. Collected groundwater would be pumped to the treatment unit, and the treated water discharged to North Criner Creek.

- alluvial groundwater restoration. Contaminants already present in the alluvium would be allowed to dissipate by natural dilution, natural biodegradation and flushing. The interceptor trenches, in conjunction with source control actions, would abate contaminant migration into the alluvium of North Criner Creek and allow natural restoration to Maximum Contaminant Levels to occur. If alluvial monitoring reveals that estimated natural restoration times and plume dilution rates are not being met, then active restoration of the alluvium would be implemented. An increase in contaminant concentrations in the alluvium after trench installation and pumping, or a decline in the mass of contaminants of less than 40 percent in 10 years, will trigger active restoration in the alluvium.

In addition to the Source Control and Groundwater components listed above, the comprehensive remedy calls for the following monitoring and support components (further described in Section 6) which are necessary as part of remedy implementation:

- institutional controls, including fencing, deed restrictions, and maintenance of the availability of an alternate water supply system. These will be implemented to restrict access to the site and contaminated groundwater.

- surface water controls to collect surface water drainage from the source areas during remedy implementation, and to divert uncontaminated runoff away from the working area in order to minimize the generation of contaminated groundwater.

- remedial monitoring to verify that the migration of contaminants has been halted. This monitoring program includes monitoring of surface water in North Criner Creek, monitoring of alluvial and bedrock groundwater onsite and offsite, including downgradient of the alluvial contamination plume, and monitoring of the performance of the groundwater interceptor trenches (or wells if used in place of the southwest interceptor trench) to determine their effectiveness in containing and reducing contamination. The caps proposed as part of the Source Control will be monitored for differential settlement or erosion. Finally, air quality would be monitored during implementation of the remedy both onsite and at the fenceline boundary. Action levels will be set onsite to assure that Maximum Ambient Air Concentrations are not exceeded at the fenceline.

DECLARATION

The selected remedy, if implemented, is protective of human health and the environment, attains Federal and State requirements that are applicable or relevant and appropriate to this remedial action and is cost-effective.

This remedy satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility or volume as a principal element and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable.

Because this remedy will result in hazardous substances remaining onsite above health based levels, a review will be conducted within five years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

Robert E. Layton Jr.

Robert E. Layton Jr., P.E.

Nov. 22, 1989

Date

HARDAGE/CRINER - RECORD OF DECISION AMENDMENT

TABLE OF CONTENTS

- 1.0 Site Location and Description
- 2.0 Site History and Enforcement Activities
  - 2.1 Disposal Operations
  - 2.2 Enforcement
  - 2.3 Site Investigations
  - 2.4 Highlights of Community Participation
- 3.0 Scope of Response Action
- 4.0 Site Characteristics
  - 4.1 Site Conditions
    - 4.1.1 Surface Water Hydrology
    - 4.1.2 Site Geology
    - 4.1.3 Groundwater Hydrology
  - 4.2 Site Contamination
    - 4.2.1 Impact of Disposal Operations
    - 4.2.2 Remaining Contaminant Sources
    - 4.2.3 Pathways and Extent of Contamination
    - 4.2.4 Future Contaminant Migration
- 5.0 Site Risks
- 6.0 Description of Alternatives
  - 6.1 Alternative Source Control Components
    - 6.1.1 No Action
    - 6.1.2 On-site Landfill (EPA 1986 ROD)
    - 6.1.3 Containment of Wastes (HSC Proposal)
    - 6.1.4 Incineration
    - 6.1.5 Liquid Extraction Wells
    - 6.1.6 In-Place Drum Lancing
    - 6.1.7 Drum Excavation
    - 6.1.8 Excavation of Wastes in Adjacent Areas
    - 6.1.9 Soil Vapor Extraction and Treatment
    - 6.1.10 Source Area Capping
  - 6.2 Groundwater Remediation Objectives and Alternative Groundwater Components
    - 6.2.1 U-shaped Trench
    - 6.2.2 V-shaped Trench
    - 6.2.3 Southwest Interceptor Trench
    - 6.2.4 Groundwater Treatment System
    - 6.2.5 Alluvial Groundwater Restoration
  - 6.3 Monitoring and Support Components
    - 6.3.1 Remedial Support Facilities
    - 6.3.2 Institutional Controls
    - 6.3.3 Surface Water Controls
    - 6.3.4 Remedial Monitoring

6.4 Comprehensive Alternatives
  6.4.1 Common Elements
  6.4.2 Revised EPA Remedy
  6.4.3 Partially Revised EPA Remedy
  6.4.4 HSC Remedy

7.0 Comparative Analysis of Alternatives
  7.1 Overall Protection of Human Health and the Environment
  7.2 Compliance with Applicable or Relevant and Appropriate Requirements
  7.3 Long-term Effectiveness and Permanence
  7.4 Reduction of Toxicity, Mobility, or Volume
  7.5 Short-term Effectiveness
  7.6 Implementability
  7.7 Cost
  7.8 State and Community Acceptance

8.0 Selected Remedy Description
  8.1 Remediation Goals

9.0 Statutory Determinations
  9.1 Protection of Human Health and the Environment
  9.2 Compliance with ARARs
  9.3 Cost Effectiveness
  9.4 Utilization of Permanent Solutions and Alternative Treatment Technologies
  9.5 Preference for Treatment as a Principal Element
  9.6 Documentation of Significant Changes

REFERENCES

APPENDICES

A. Evaluation of Applicable or Relevant and Appropriate Requirements

B. Agency for Toxic Substances and Disease Registry (ATSDR)/Center for Disease Control (CDC) Evaluation

C. Administrative Record Index

D. State of Oklahoma Correspondence

E. Responsiveness Summary

F. 1986 Source Control Record of Decision

G. Detailed Cost Evaluation of the Selected Remedy

LIST OF FIGURES

1-1. Vicinity Map
1-2. Site and Disposal Operations Map

4-1. North Criner Creek Drainage Basin Map
4-2. Surface Water Hydrology
4-3. Geologic Cross-Section
4-4. Hydrogeologic Cross-Section
4-5. Main Pit and Barrel Mound Pit Cross-Section
4-6. Approximate Extent of Groundwater Contamination
4-7. Distribution of Total Volatile Organics in Stratum III and the Alluvium
6-1. Conceptual Drum Lancing Diagram
6-2. Areas Targeted for Drum Excavation
6-3. Schematic of Soil Vapor Extraction
6-4. Final Source Area Cap
6-5. Alternative C Site Schematic, Second Operable Unit Feasibility Study
6-6. Alternative E Site Schematic, Second Operable Unit Feasibility Study
6-7. Site Cross-Section Showing Trenches
8-1. Schematic of Selected Remedy

LIST OF TABLES

2-1. Summary of Drummed Wastes from Manifests
4-1. Carcinogens Detected in the Source Area Characterization Holes
4-2. Comparison of Groundwater Data with MCLs.
6-1. Summary of Alternative Elements, Second Operable Unit Feasibility Study
6-2. Comparison of Alternatives
7-1. Comparison Summary According to Statutory Criteria
7-2. Drum Excavations Performed at Other Sites
8-1. Cost of Selected Remedy

1.0 SITE LOCATION AND DESCRIPTION

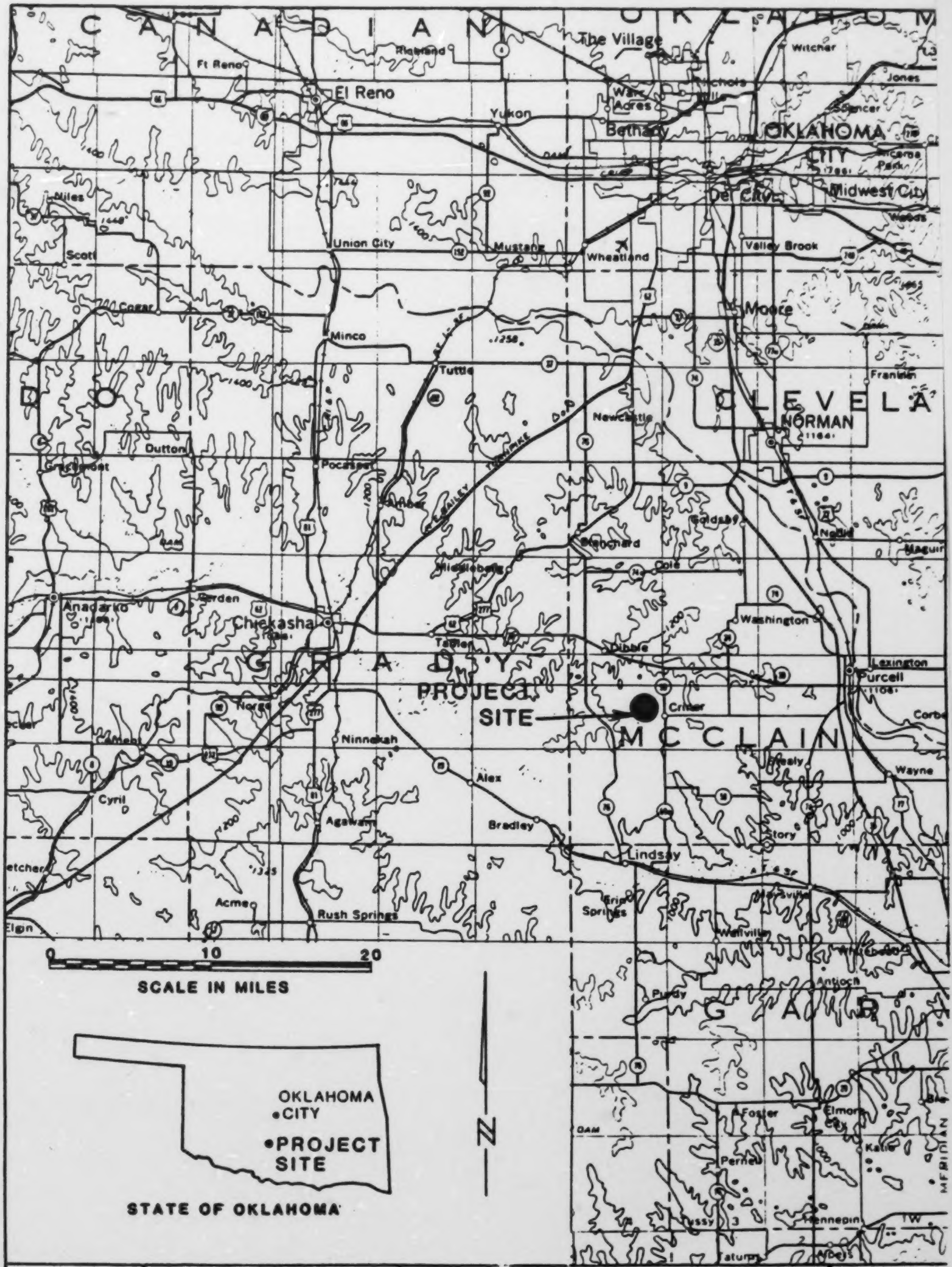
The Hardage site is located in a rural area of McClain County in central Oklahoma, approximately 25 miles south-southwest of Oklahoma City (Figure 1-1). The site is bounded on the South by old Oklahoma State Highway 122, on the north by open farmland, on the west by a gravel (County) road, and on the east by a series of three small ponds (Figure 1-2).

The Hardage site was operated from 1972 to 1980 under a permit issued by the Oklahoma State Department of Health (OSDH) for the disposal of industrial wastes. In 1983, EPA placed the site on the "National Priorities List" (48 Fed. Reg. 40658) for response under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). EPA has taken the lead in response to this site. OSDH has provided technical support and advice to EPA, particularly in the early stages of work on the site, and has been consulted on remedy selection.

As a result of waste disposal practices at the site, chemicals have migrated vertically and laterally resulting in the contamination of approximately 70 acres of groundwater beneath and adjacent to the site as well as several acres of surface soil in the immediate vicinity of the main disposal areas. The principal source of contamination is some 278,000 cubic yards of sludges, waste drums, highly contaminated soils, and waste liquids contained in three waste areas near the center of the property.

The disposal areas at the site were a number of permanent and temporary impoundments into which a variety of liquid, sludge, and solid wastes were disposed and mixed. These areas, described more fully in Section 2.1, were primarily the Main Pit, Sludge Mound, and Barrel Mound, and in addition the North Pit, West (mixing) Ponds, and East (mixing) Ponds (see Figure 1-2). During 1980 - 1981 the operator consolidated wastes into the Main Pit, Barrel Mound, and Sludge Mound and capped those areas with two to three feet of local soil in an effort to permanently close the site. Closure efforts failed, however, to prevent the migration of hazardous substances vertically and laterally into groundwater from the impoundments. More specifically, dense non-aqueous phase liquids have pooled beneath the Main Pit, Barrel Mound and to some extent the Sludge Mound and now serve as a continuing source of contamination to the groundwater. Volatile organic compounds, many of them known or suspected carcinogens, have migrated from these areas offsite into the alluvium of North Criner Creek, forming a plume of contamination extending a distance of about 2800 feet southwest of the Main Pit. Total concentrations of volatile organic compounds in the plume exceed 25,000 ppb near the source areas and decrease systematically away from the source areas, with concentrations as high as a few hundred ppb more than 2500 feet away from the Main Pit to the southwest. Volatile organic compounds are entering North Criner Creek at sufficient quantities to cause detectable concentrations in surface water in the Creek.

Present and near-term risks are related primarily to groundwater resources and any individuals who might use the contaminated groundwater. Over the long-term, risks will also be posed due to erosion of wastes and their gradual surface and subsurface migration across and from the site.


CANADIAN
OKLAHOMA
The Village
Witcher
Jones
Richland
Ft Reno
El Reno
Yukon
War Acres
Nichols Hills
Spencer
Bethany
OKLAHOMA CITY
Midwest City
Del City
Niles
Scott
Union City
Mustang
Wheatland
Valley Brook
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Chickasha
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Dibble
GRADY
Lexington
Purcell
PROJECT SITE
Criner
Norge
Ninnekah
McCLAIN
Cement
Cyril
Alex
Paoli
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Agawam
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Elmore City
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OKLAHOMA CITY
PROJECT SITE
STATE OF OKLAHOMA
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HARDAGE INDUSTRIAL
WASTE SITE
REMEDY COMPARISON REPORT

VICINITY MAP

FIGURE 1-1

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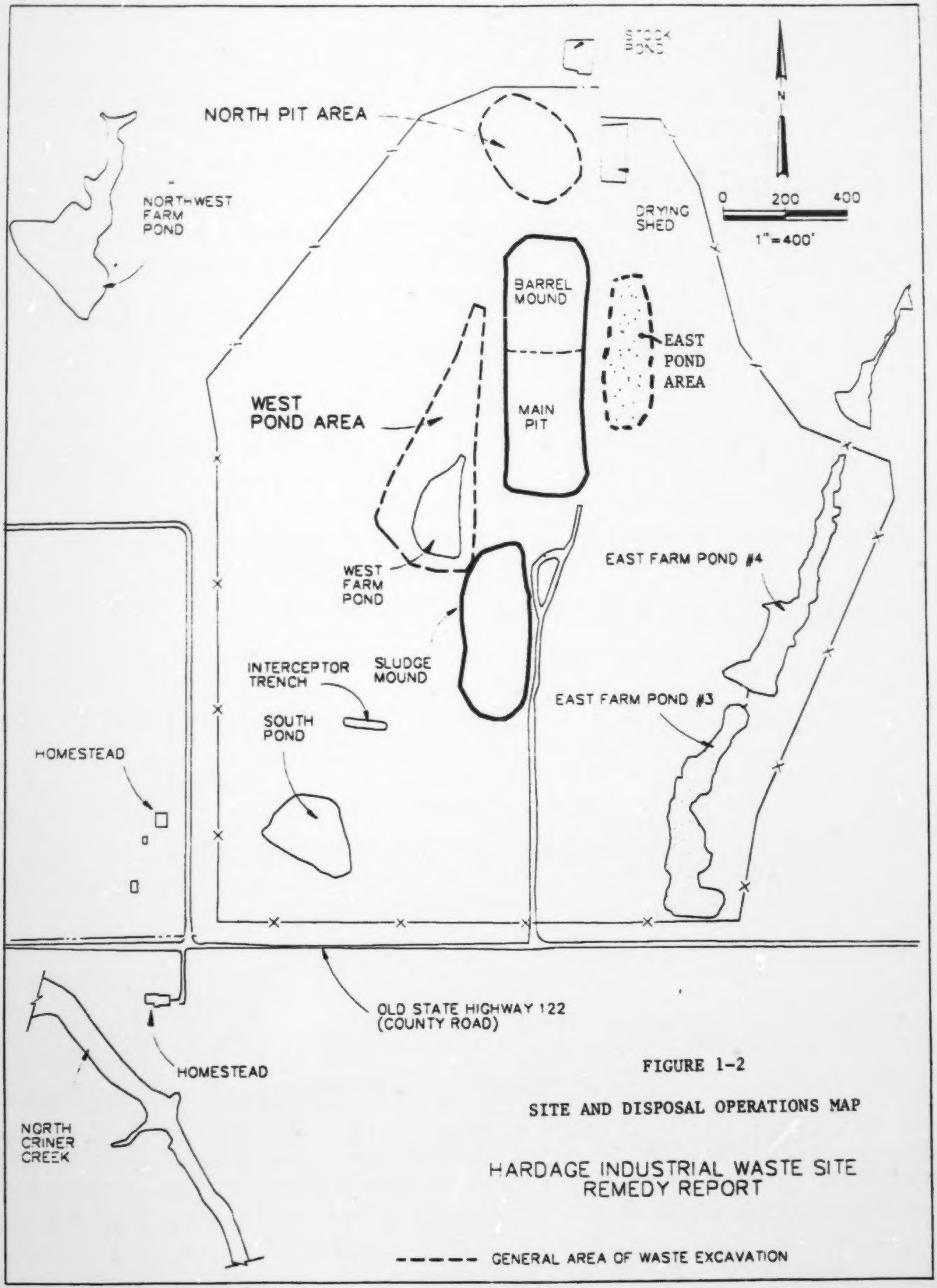

STOCK POND
N
0 200 400
1"=400'
NORTH PIT AREA
NORTHWEST FARM POND
DRYING SHED
BARREL MOUND
EAST POND AREA
MAIN PIT
WEST POND AREA
WEST FARM POND
EAST FARM POND #4
INTERCEPTOR TRENCH
SLUDGE MOUND
EAST FARM POND #3
SOUTH POND
HOMESTEAD
OLD STATE HIGHWAY 122 (COUNTY ROAD)
HOMESTEAD
NORTH CRINER CREEK
GENERAL AREA OF WASTE EXCAVATION

FIGURE 1-2

SITE AND DISPOSAL OPERATIONS MAP

HARDAGE INDUSTRIAL WASTE SITE
REMEDY REPORT

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

2.1 Disposal Operations

In 1972 the site owner and operator Royal Hardage, received a permit from the Oklahoma State Department of Health (OSDH) to operate a hazardous and industrial waste landfill at the site. This permit was based on an application by Mr. Hardage that consisted of a general outline of planned operations and limited subsurface boring data on site geology.

From September 1972 until November 1980 the site accepted approximately 21 million gallons of hazardous and industrial wastes including paint sludges and solids, ink solvents, tire manufacturing wastes, oils and solvents such trichloroethene, corrosives, plating wastes sludges, cyanides, and caustic wastes, many of which are now regulated as hazardous waste under the Resource Conservation and Recovery Act (RCRA). The liquid portion of this waste was initially discharged into the Main Pit. Early in the operation, problems began to occur due to slower than expected evaporation of wastes. To deal with this problem, the operator began spraying liquids over the Main Pit to enhance evaporation and also drained some of the liquids into adjacent temporary mixing ponds for bulking with soil. The soil/waste mixture was disposed in a new area called the Sludge Mound. Sludge waste, including residue from oil recycling and styrene tar production, and some drums of solid material, were also disposed in the Sludge Mound.

In addition to the bulk waste liquids disposal described above, drums of waste were also received at the site. These waste drums were initially opened and dumped into the Main Pit. This practice, however, became less common after about 1974. During most of the operations, drums were dumped off trucks into two areas, the west side of the Main Pit and the Barrel Mound. The Barrel Mound area adjoins the north end of the Main Pit and was built to a height of 25 to 30 feet by trucks dumping drums off of the south side of the mound, filling soil over and around the drums, and dumping of additional drums onto the previously dumped drums. Many of the drums at the site were carelessly dumped into the pits, without any attempt to avoid rupturing. Some drums were rolled off trucks down the face of the Barrel Mound. Other drums dumped into the pits were not sealed to begin with. As a result, a substantial number of these drums spilled or broke open during the disposal operation resulting in the direct release of large volumes of hazardous and carcinogenic chemicals into soils and eventually groundwater. Many of the drums, however, were disposed intact, as shown by accounts of the site operation (Hardage, 1987). Moreover, intact drums were excavated and removed from the site during exploratory excavations in 1988 (EPA, 1988). A summary of drummed wastes brought to the site (from manifests) is presented in Table 2-1.

In addition to disposal practices in the source areas (Barrel Mound, Main Pit, and Sludge Mound) waste mixing and transfer operations were conducted over much of the site in areas known as the North Pit, East Pond area, and West Pond area. The disposal areas and site activities described above are illustrated in Figure 1-2.

Table 2-1
SUMMARY OF DRUMMED WASTES FROM MANIFESTS

Waste Category	No. of Containers Received	Estimated Volume Received[1] (gallons)
Paint		
Sludge	5,897	324,047
Paints and Related Wastes	1,044	57,420
Solids	451	24,805
Mixed Wastes		
Mixed Wastes	2,557	138,600
Tire Manufacturing Wastes (Carbon Black, Soap, Oil, Solvents, Rubber)	1,405	77,275
Soap, Oil, Solvents	304	16,720
Acid		
Rinse Water	1,867	102,685
Sulfuric Acid	880	48,400
Sludges	676	37,180
Acids	341	18,755
Chromic Acid	248	13,565
Nitric Acid	194	10,670
Acids and solvents	31	1,705
Muriatic Acid	13	715
Acrylic Acid	12	660
Hydrofluoric	4	220
Oils and Solvents (TCE, Stoddard)	3,253	177,815
Asbestos	1,345	73,975
Oil		
Oils	660	36,300
Sludge	132	5,790
Alumina Silica Slurry	747	41,085
Ink		
Inks	520	30,425
Solvent	57	3,135
Sludge	47	2,585
Caustic	580	31,900

Table 2-1
(continued)

Waste Category	No. of Containers Received	Estimated Volume Received(1) (gallons)
Cupric Ammonium Persulfate and Toxic Tin	435	23,925
Corrosive	357	19,635
MDI (methylene bisphenyl isocyanate)	299	16,325
Plastic Wastes	261	14,355
Aromatic Residue	232	12,760
Chemical Wastes	229	12,595
Plating Waste Sludge	214	11,770
Cyanide (Copper, Potassium, Sodium)	142	7,760
Shopwaste	111	6,105
Nitric Alumina	91	5,005
Glue	84	4,620
Alumina Oxide	80	4,400
Filter Cake	80	4,400
Methanol	80	4,400
Sediment Pit Waste	62	3,410
Zinc, Arsenic	33	1,782
PCBs	29	1,595
Laboratory Chemical Packs (Phosgene Gas Canister, Reagents, Waste Chemicals)	27	1,385
Toxaphene	145	1,375

Table 2-1
(continued)

Waste Category	No. of Containers Received	Estimated Volume Received[1] (gallons)
Polyacrylamide	14	770
Sand Filter Sludge	11	605
Ammonium Bifloride	8	440
Selenium	8	440
Emulsion	6	330
Trichloroethene and Aluminum	63	315
Chromium	20	300
Waste Chlorides	142	142
Insecticides	3	165
Salt Sludge	2	110
Ammonium Hydroxide	55	55
Chlorine	1	55
Sodium Lead Alloy	1	28
2,4-Dinitrophenyl Hydrazine	1	-
Pesticide with Arsenic	1	-
Vaccine	1	-
TOTAL	25,593	1,437,809

(1) Unless indicated on manifest, Hardage (1972-1980) containers were assumed to be 55-gallon drums. All containers were assumed to be full.

2.2 Enforcement

In 1979, OSDH and EPA inspections and sampling of the site indicated waste management practices were posing potential threats to public health and the environment. In September 1980, the United States, on behalf of EPA, filed a complaint in the U.S. District Court for the Western District of Oklahoma. The complaint sought injunctive relief under Section 7003 of RCRA for the proper cleanup and closure of the site. The facility ceased operations in early November 1980, before Interim Status Standards under the RCRA came into effect.

In 1982, United States amended the existing complaint against the facility owner and operator Royal Hardage, to request relief under Sections 106 and 107 of the CERCLA. In December 1982, the Court found that the site posed an "imminent and substantial endangerment to public health and welfare and the environment" as defined by CERCLA Section 106 and RCRA Section 7003. In August 1983, the Court granted a partial judgment for over $211,000 in response costs, which EPA had incurred through 1982, against Royal Hardage. Hardage filed for bankruptcy in 1983 and again in 1985, and EPA has to date not recovered its partial judgment.

In December 1984, EPA mailed letters to 289 Potentially Responsible Parties (PRPs) requesting information about their waste disposal at the Hardage site under authority of Section 104(e) of CERCLA and Section 3007 of RCRA and notifying the PRPs of their potential liability for site cleanup. As further information was gained, information request and notice letters were sent to additional PRPs identified. At the present time, over 400 PRPs have been identified. Various PRPs have gone out of business or cannot be located; therefore, approximately 340 have been contacted. A group of these parties organized into the Hardage Steering Committee (HSC) and met with EPA and OSDH on numerous occasions concerning the site. Initial meetings with the HSC were held in January of 1985.

In May 1985, EPA released a report entitled Field Investigation and Data Summary Report (DSR) for the Royal Hardage Waste Disposal Site (EPA, 1985) documenting investigations conducted in 1984 and earlier. This document served as a remedial investigation (RI) report for the site.

After completion of the DSR, EPA determined that sufficient data were available to develop a remedy for the contaminant source areas, but that the information was inadequate to develop remedial alternatives for the contaminants that had already migrated from the source areas into groundwater. Accordingly, selection of a comprehensive alternative for a complete remedial action, addressing surface and subsurface contamination beyond the source areas, was not possible at that time. The need for control of the source areas at the site prompted EPA to consider alternatives that would reduce or eliminate the spread of contaminants off the site. Therefore, EPA decided, in accordance with Section 300.68(c) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), to divide the remedial process of the site into two operable units: 1) Source Control and 2) Management of Migration (groundwater).

During 1985, EPA began preparing a Feasibility Study (FS) for the Source Control Operable Unit primarily addressing the three principal waste source areas: the Main Pit, the Barrel Mound and the Sludge Mound.

EPA's FS, entitled Feasibility Study - Source Control - Royal Hardage Industrial Waste Site Near Criner, Oklahoma (EPA, 1986a), presented the methodology used to develop several remedial action alternatives for the Source Control Operable Unit. The alternatives, further discussed in Section 6, were evaluated in accordance with the NCP, and four alternatives were developed in detail. These four alternatives included onsite waste stabilization with disposal in a RCRA-compliant landfill, onsite incineration and disposal, offsite incineration and disposal, and onsite waste stabilization and disposal in an offsite RCRA-compliant landfill.

In November 1986, EPA issued its Record of Decision (ROD) outlining the selected final remedy for the Source Control Operable Unit (see Appendix F). This remedy was selected in a manner consistent with CERCLA, as amended, and the NCP as the most appropriate remedy for source control considering all relevant selection criteria. The selected remedy consisted of excavating, treating, and disposing of solids in a RCRA-compliant onsite landfill; removal and offsite incineration of free organic liquids; and the onsite treatment and disposal of other water-based liquid wastes. After potentially responsible parties declined to implement the selected remedy, EPA subsequently initiated the remedial design process with the design-related field activities. The detailed design was presented in EPA's Design Report - Source Control Remedial Design - Hardage Industrial Waste Site - Criner Oklahoma (EPA, 1988).

Prior to EPA's 1986 ROD, additional field studies were initiated by the HSC. This work involved the gathering of geologic and hydrologic data at the Hardage site to assess an in-place containment remedy later proposed by the HSC. As a result of this work, the HSC submitted the Final Confirmatory Bedrock Study in December of 1986 (HSC 1986). As a part of the EPA's public comment process for the ROD, the HSC's report also briefly presented the the HSC's proposed source control remedy. The HSC remedy called for in-place containment of the waste source areas by a cut-off wall supplemented by groundwater pumping. Differences between the HSC and EPA source control proposals were not resolved and resulted in litigation over implementation of the selected remedy. Work by the HSC in support of their proposed remedy continued at the site through November 1, 1988. Additional characterization of the source areas was conducted and reported in the HSC's Mound Characterization Field Study (HSC, 1988). From these and other studies performed as a part of the HSC's litigation efforts, the HSC prepared a Recommended Source Control Remedy design report (HSC, 1988) which provided additional technical details of the HSC's proposed remedy.

Meanwhile, in July 1985 the Court administratively closed the 1980 case against Hardage, providing that the U.S. could re-open the case for the purpose of seeking appropriate relief until April 1, 1986, at which time the case would otherwise be dismissed. The United States, on behalf of EPA, filed a motion on March 27, 1986, to amend the existing complaint and add newly discovered generators and transporters to the existing case. The Court ultimately denied the motion and dismissed the case. On June 25, 1986, the United States filed a new complaint naming 36 generators and transporters of waste at the site. The complaint asked for performance of the EPA selected source control remedy, maintenance of site security, conduct of a RI/FS for the management of migration (groundwater) operable unit, implementation of the groundwater operable unit remedy to be selected by EPA, and recovery of EPA's past and future response costs.

In 1987 the District Court issued a ruling indicating that the case would be decided in a "de-novo" trial, as opposed to a trial on the Administrative Record. The Court, in issuing that ruling, cited two factors peculiar to the case. First, the case was filed prior to the enactment of the Superfund Amendments and Reauthorization Act of 1986 (SARA), which called for Administrative Record review at trial. Second, the case was filed under RCRA as well as CERCLA; and RCRA does not mandate an Administrative Record trial.

After lengthy negotiations, a Partial Consent Decree between EPA and HSC was entered by the Court in February 1988. Under this Decree, HSC agreed to conduct a RI/FS addressing management of contaminant migration at the site under EPA oversight. The second operable unit RI/FS, and Endangement Assessment reports were submitted to EPA in the spring of 1989, finalized and sent to repositories in October of 1989.

Throughout 1988 both EPA and HSC took extensive depositions of both fact and expert witnesses. In early 1989, the Government initiated meetings with HSC to discuss ways of resolving on-going litigation.

On April 7, 1989 a Consent Decree was lodged with the U.S. District Court between EPA and approximately 170 "de minimis" (small quantity) PRPs for the site. Under this agreement, the de minimis parties resolved their liability for the site by making two cash payments: one to EPA to cover past costs incurred, and a second to a trust fund to be supervised by the District Court. The trust fund will be used for site remediation. This Consent Decree was entered by the court on September 22, 1989. The de minimis agreement was prepared in accordance with EPA's Interim Guidance on Settlement with De Minimis Waste Contributors under Section 122(g) of SARA (June 19, 1987) 52 Fed. Reg. 24333 (June 30, 1987).

2.3 Site Investigations

Studies of the Hardage site have been conducted since 1982. These studies, some of which were mentioned in Section 2.2, are part of EPA's administrative record for the site, and are described below:

March 1982

Ecology and Environment (E&E), an EPA contractor, sampled surface soils, drainage ways, and existing wells at the site. E&E also installed and sampled ten monitoring wells on and around the site. These wells are designated EW-1 through EW-10. This investigation is documented in a May 7, 1982 letter report from Imre Sekelyhidi of E&E.

August 1984

EPA contractor CH$_2$M Hill and its subcontractors Chen Associates, Wright Water Associates, and Davenport-Hadley conducted a site investigation in 1984 to supplement the 1982 E&E data and allow selection by EPA of a source control remedy. This investigation involved installation and sampling of monitoring wells (the "GTW", "BW", "PW", and "AW" series of wells), limited coring of bedrock, sampling of the source areas, and sampling of shallow test pits. This investigation is documented in the the May 1985 report "Field Investigation and Data Summary Report" (DSR) prepared by CH$_2$M Hill.

July - November 1986

HSC contractor ERM-Southwest conducted an investigation centering on conditions of the bedrock in the immediate vicinity of the source areas. This investigation included installation of monitoring wells and well nests MW-1 through MW-11, sampling of the shallow wells, resampling of some existing wells, and drilling vertical and slanted test borings B-1 through B-13 and SB-1 through SB-7. This investigation is documented in the December 1986 report "Confirmatory Bedrock Study" prepared by ERM-Southwest.

May 1987

E&E, on behalf of EPA, collected samples from all monitoring wells at the site. This work was monitored, and split samples collected by ERM-Southwest on behalf of HSC. HSC also recorded all work under the six week long project on videotape. The results of their sampling are documented in an August 31, 1987 letter report from E&E and in the Management of Migration RI.

October 1987 and March 1988

ERM-Southwest, on behalf of HSC, drilled fourteen cores MB-1 through MB-14 into the waste source areas for chemical sampling and observation of physical conditions. This activity is documented in the HSC's "Mound Characterization Field Study" prepared by ERM-Southwest in November of 1988.

January - April 1988

ERM-Southwest, acting as litigation consultants on behalf of HSC, conducted a variety of activities on the site, including drilling of deep core holes (the "DH" holes), drilling of slant cores, photo-linear analysis, geophysical logging, reflection and cross-hole geophysics, radioisotope dating, and sampling of chloride for geochemical modeling. This activity is documented in the November 1988 report "Hydrogeologic Issues of Relevance to the Hardage Site" prepared by S.S. Papadopulos Associates.

April 1988 - October 1988

CH_2M Hill and its subcontractor Chen Associates, acting on behalf of EPA, drilled eight bore holes into the source areas to retrieve samples for geotechnical and stabilization testing and to provide data on air emission of VOCs. Two test pits were also excavated to provide further data on air emmissions and on integrity of the buried steel drums. This activity is documented in the November 1988 report "Source Control Remedial Design" prepared by CH_2M Hill.

July - October 1988

ERM-Southwest, on behalf of HSC and working under EPA oversight, conducted a comprehensive investigation of the extent of contamination and physical conditions at the site relative to migration of contaminants. This activity is documented in the May 1989 draft report "Second Operable Unit Remedial Investigation" (also refered to as the Management of Migration RI or Groundwater RI). ERM-Southwest also prepared and submitted to EPA a May 1989 draft "Second Operable Unit Feasibility Study Report" (or Groundwater FS). Both of these reports underwent revision based on EPA comment, were then approved by EPA and sent to repositories in October of 1989. HSC provided replacement pages to EPA during the public comment period which are addressed in the responsiveness summary in Appendix E.

2.4 Highlights of Community Participation

In preparation for this ROD amendment, EPA held a public comment period on the proposed comprehensive remedy. The comment period began October 13, 1989, and closed November 2, 1989. EPA provided notice of the public comment period through announcement in the newspaper on October 1, 1989, and at that time announced a public meeting on the proposed remedy. A fact sheet was prepared by EPA summarizing alternatives for both source control and groundwater and was sent to repositories and addressees on the site mailing list on October 12, 1989. EPA's Remedy Comparison Report and Remedy Report, along with the Administrative Record, were also sent to repositories on this date. A public meeting on the proposed remedy for the site was held on October 26, 1989, and approximately 40 people were in attendance.

EPA has addressed questions received during the public comment period, including those received at the public meeting, in the responsiveness summary (Appendix E).

3.0 SCOPE OF RESPONSE ACTION

The proposed remedy would address both the Source Control and Groundwater (Management of Migration) aspects of the Hardage site in a comprehensive remedial action. This proposed comprehensive remedy would remove a substantial portion of the liquid wastes, including many highly toxic and mobile volatile organic compounds, from source areas, thereby reducing the volume, toxicity, and mobility of the hazardous substances at the site. Moreover, this proposed comprehensive remedy would prevent further contamination of the alluvial aquifer.

To date the site has been investigated as two "operable units" - Source Control and Management of Migration or Groundwater. This approach was adopted in 1985 in an effort to speed remediation of the site. On November 14, 1986, EPA issued a ROD for the Source Control Operable Unit. This ROD selected a remedy, as previously discussed in Section 2.2, consisting of waste excavation and segregation followed by incineration of organic liquids and stabilization and consolidation of solids into a new landfill to be constructed on the site. Protracted litigation from 1986 through 1989 delayed implementation of the selected source control remedy.

In 1987 HSC agreed, pursuant to a partial Consent Decree with EPA, to conduct a RI/FS for the Groundwater Operable Unit of the site. Field studies were conducted in 1988 and a draft FS report was completed in May 1989 evaluating several remedial alternatives for groundwater at the site. It was proposed that any groundwater actions would be implemented in conjunction with a Source Control remedy.

Subsequent to the completion of EPA's Remedial Design Report, an issue arose concerning the potential impact of the RCRA land disposal restrictions on certain elements of the Source Control remedy selected in the 1986 ROD. The Agency's interpretation of the applicability of the land disposal restrictions to CERCLA response actions was then still evolving. Due to uncertainties over the ultimate resolution of this issue, EPA began to consider other alternatives for the Source Control remedy, which could unquestionably be implemented consistent with the RCRA requirements. Because of the timing of the draft Groundwater FS, and the concurrent evaluation of new Source Control technologies, EPA found it efficient and logical to combine Groundwater and Source Control alternatives in order to develop remedial alternatives that would address the entire site. As a result, a number of comprehensive remedial alternatives were assembled from source control and groundwater operable unit alternatives. Comprehensive alternatives are addressed in Section 6.4 and involve amendments to the 1986 ROD for source control and the selection of a remedial response actions for contaminated groundwater. One of those alternatives is presented as the selected comprehensive remedy for the site (see Section 7 for remedy selection criteria).

The proposed remedy would remove a substantial portion of the liquid wastes from the source areas. The Barrel Mound, and those portions of the Main Pit believed to contain drums, would be excavated. Containerized liquids, and free-phase liquids in the source areas, would be removed for offsite destruction. In addition, a relatively new technology, in-situ soil vapor extraction, would be implemented in the source areas to reduce those compounds most mobile in the environment. Soil vapor extraction would be effective in removing volatile and semi-volatile compounds, a number of which are carcinogenic, from the vadose zone, and from the surface of free-phase liquids in the source areas.

The proposed remedy would also prevent further contamination of the alluvial aquifer associated with North Criner Creek. Groundwater interceptor trenches (or possibly interceptor wells in the alluvial recovery area) would be installed to arrest migration of the plume of contamination from the site, and thereby allow the gradual process of restoration in the bedrock and alluvial systems to begin. Groundwater monitoring, institutional controls, and controls on the use of groundwater and surface water would be implemented to assure that humans are not exposed to contaminants.

4.0 SITE CHARACTERISTICS

4.1 Site Conditions

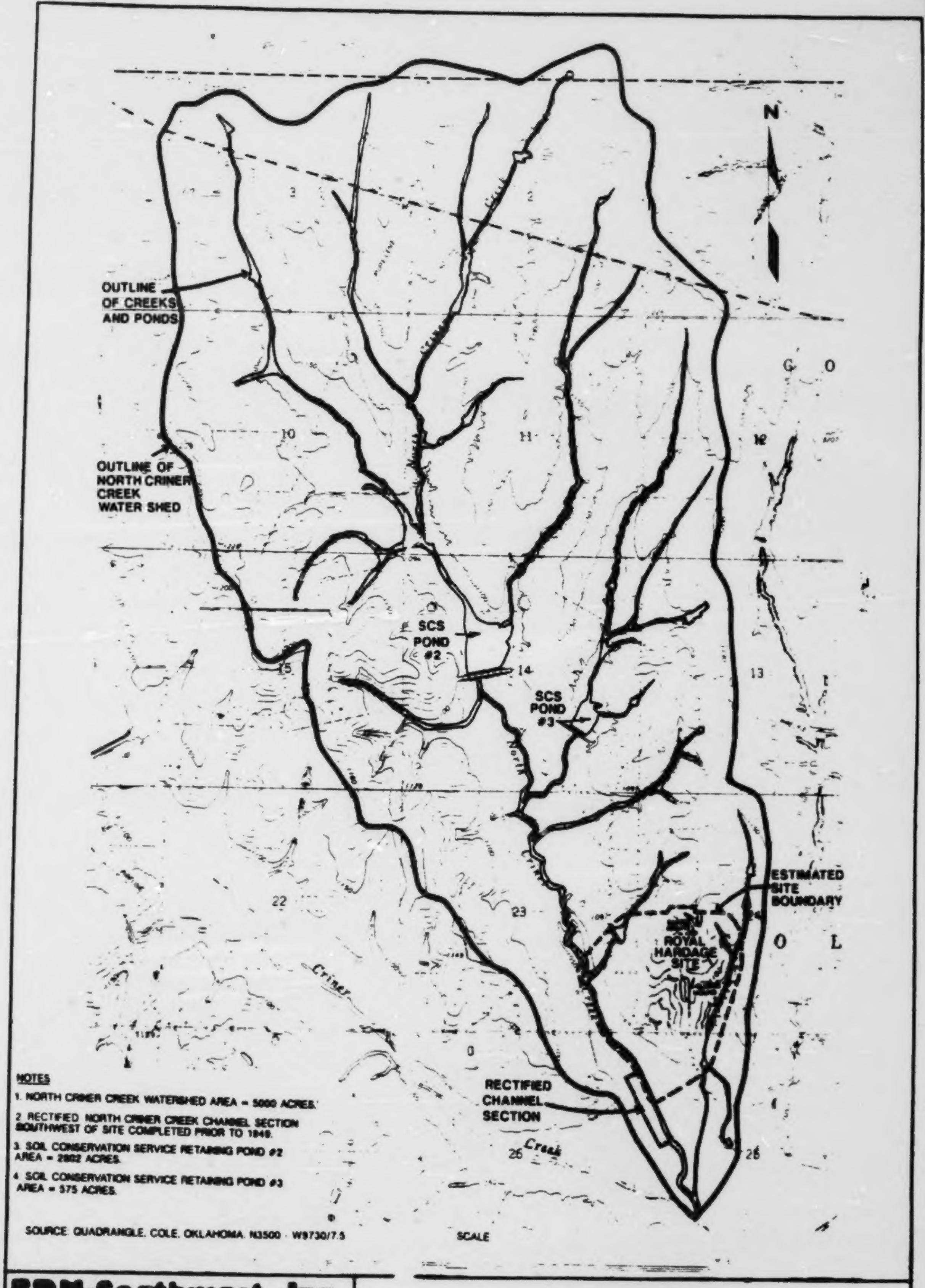
The Hardage site is situated on gently rolling property in a rural area of South Central Oklahoma. The principal disposal operations were conducted along a north-south trending ridge at the center of the property. Relief is about 100 feet from the ridge to the adjacent stream valley. The site is bounded on the southwest by the floodplain of a small perennial stream, and on the east by a series of three small ponds. Soil cover on the site is thin and subject to erosion. The underlying bedrock consists of a series of interbedded sandstones, siltstones, and mudstone. These rocks are fractured, as is well documented in various published studies including observation of cores, rock outcrops, and geophysical logs of borings.

The waste remaining onsite is primarily located in three source areas, the Main Pit, Barrel Mound and Sludge Mound. These three source areas will continue to release contaminants into the environment primarily via groundwater flow. At present, a groundwater plume of volatile organic contamination extends some 2800 feet southwest of the Main Pit with concentrations of volatile organic compounds exceeding 25,000 ppb. The plume ranges in width from about 1800 feet near the source areas to about 800 feet in the southwest corner of the site (see Section 4.2.3, Figure 4-6). Contaminants have migrated vertically and laterally from the source areas into the surrounding and underlying bedrock, both in dissolved form and as non-aqueous phase liquids (NAPL). The present and future migration of contaminants will continue via groundwater flow. Eventually, erosion may also carry wastes off the site from the three source areas and adjacent mixing areas.

4.1.1 Surface Water Hydrology

The site is situated in the North Criner Creek drainage basin, approximately 0.8 miles from the confluence of North Criner Creek and Criner Creek (Figure 4-1). The drainage basin drains approximately 5,000 acres, and extends about four miles north of the site to the regional drainage divide between the Washita and Canadian rivers. The site, as stated above, is disected by a north-south trending ridge which controls runoff from the site (see Figure 4-2). Runoff from the western side of the site eventually enters a perennial stream, North Criner Creek, west and southwest of the site. Runoff from the east side of the site enters a series of three small ponds (the East Farm Ponds). These ponds drain southward through a fourth pond located on adjacent property before entering North Criner Creek south of the site. Drainage from the east side of the site is diverted from the east farm ponds by a berm and enters the stream below the southern most pond.

Drainage on the west side of the site from the source areas and much of the former operation area is channeled around an interceptor trench constructed by Royal Hardage to an impoundment known as the South Pond at the southwest corner of the site. The south pond is constructed such that an open discharge


R27E
N
OUTLINE OF CREEKS AND PONDS
OUTLINE OF NORTH CRINER CREEK WATER SHED
SCS POND #2
SCS POND #3
ESTIMATED SITE BOUNDARY
ROYAL HARDAGE SITE
RECTIFIED CHANNEL SECTION
North Criner
Criner
Creek
3
2
10
11
12
13
14
15
22
23
26
28
G O
O L
SCALE

NOTES

1. NORTH CRINER CREEK WATERSHED AREA = 5000 ACRES.
2. RECTIFIED NORTH CRINER CREEK CHANNEL SECTION SOUTHWEST OF SITE COMPLETED PRIOR TO 1949.
3. SOIL CONSERVATION SERVICE RETAINING POND #2 AREA = 2802 ACRES.
4. SOIL CONSERVATION SERVICE RETAINING POND #3 AREA = 575 ACRES.

SOURCE: QUADRANGLE, COLE, OKLAHOMA. N3500 - W9730/7.5

ERM-Southwest, Inc.
NEW ORLEANS, LOUISIANA
HOUSTON, TEXAS

DATE 5/01/89
W.O. NO 78618070

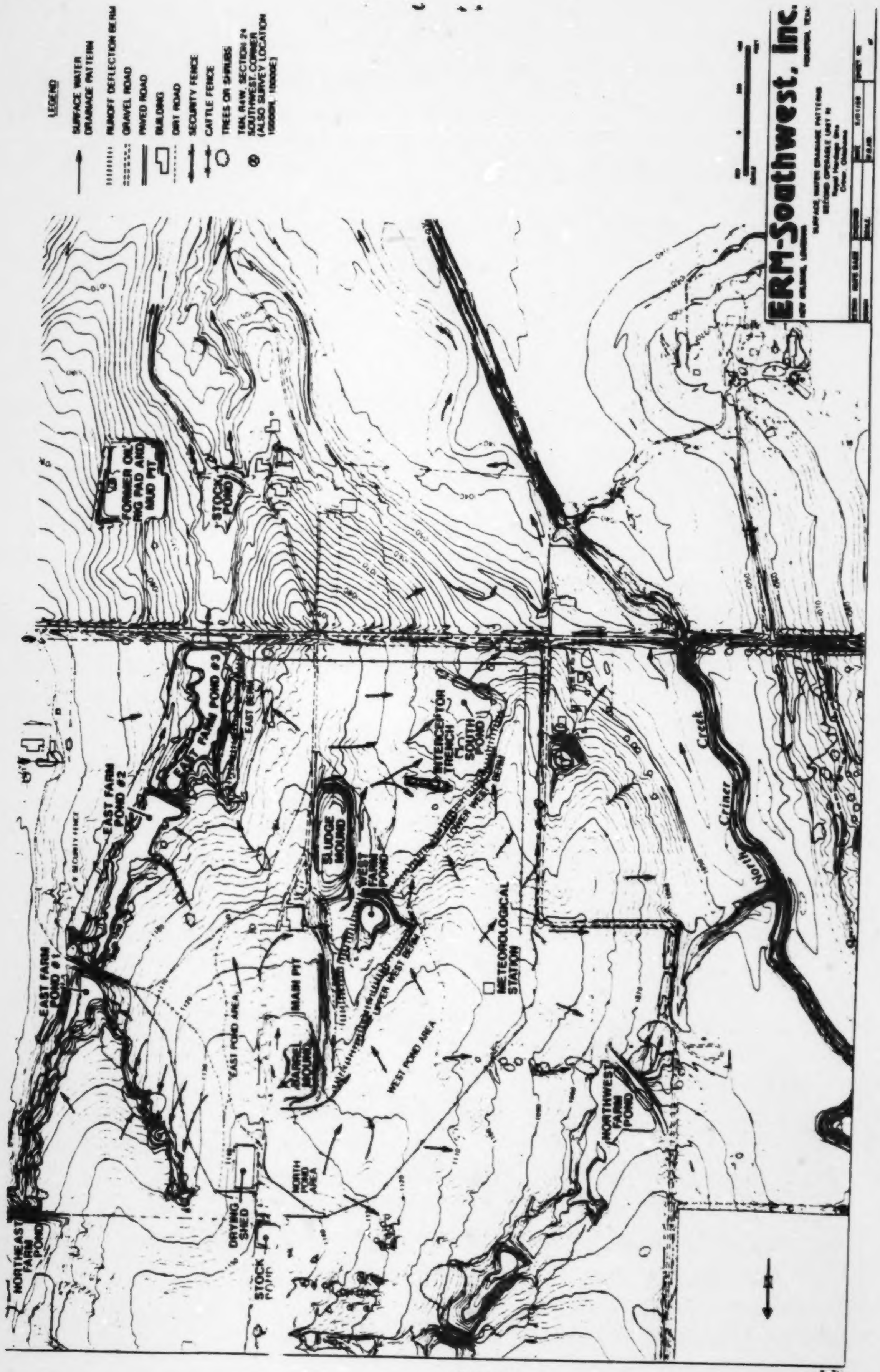
NORTH CRINER CREEK WATERSHED
Second Operable Unit RI
Royal Hardage Site
Criner, Oklahoma

FIGURE 4-1

Reproduced from best available copy.

FIGURE 4-2

SURFACE WATER HYDROLOGY


NORTHEAST FARM POND
EAST FARM POND #1
EAST FARM POND #2
EAST FARM POND #3
EAST BERM
SECURITY FENCE
FORMER OIL RIG PAD AND MUD PIT
STOCK POND
DRYING SHED
STOCK POND
NORTH POND AREA
EAST POND AREA
MAIN PIT
SLUDGE MOUND
WEST FARM POND
UPPER WEST BERM
LOWER WEST BERM
WEST POND AREA
INTERCEPTOR TRENCH
SOUTH POND
METEOROLOGICAL STATION
NORTHWEST FARM POND
North Criner Creek
LEGEND
SURFACE WATER DRAINAGE PATTERN
RUNOFF DEFLECTION BERM
GRAVEL ROAD
PAVED ROAD
BUILDING
DIRT ROAD
SECURITY FENCE
CATTLE FENCE
TREES OR SHRUBS
T6N, R4W, SECTION 24 SOUTHWEST CORNER (ALSO SURVEY LOCATION 10000N, 10000E)
ERM-Southwest, Inc.
HOUSTON, TEXAS
SURFACE WATER DRAINAGE PATTERN
N

pipe near its base releases water to flow south into a roadside ditch. An unknown fraction of this water infiltrates downward from the pond. Runoff from the westernmost portion of the site is diverted around the south pond and enters-the roadside ditch directly.

The southwest corner of the site abuts the North Criner Creek flood plain. North Criner Creek is a perennial stream with a nominal discharge of 0.8 to 1.3 cfs. The stream has been channelized directly south of the site.

The principal ponds, streams, and surface flow divides and paths are shown on Figure 4-2.

4.1.2 Site Geology

Bedrock beneath the site consists of a sequence of Permian aged sediments which grade from sandstone to siltstone, and mudstone. Despite the graditional nature of these deposits, extensive core samples have illustrated lateral continuity of four shallow bedrock zones refered to as Stratum I through IV. Bedding dips at outcrop locations near the site are less than one degree to the west and southwest.

Bedrock immediately beneath the Main Pit and Barrel Mound is comprised of a thin sequence of sandstone and siltstone (Stratum I). Approximately twenty feet beneath the Main Pit begins a sequence of mudstone/siltstone (Stratum II) approximately 20 feet thick. Beneath this is a sandstone/siltstone sequence (Stratum III) which is about 30 feet thick. Underlying Stratum III is a thick sequence of low permeability siltstone and mudstone, the upper 20 feet of which exhibits a predominance of siltstone. This bedrock sequence is illustrated in the generalized geologic cross-section shown in Figure 4-3. Bedrock over the entire site has been subject to natural weathering processes. As a result, the upper 20 to 40 feet of bedrock has been appreciably altered.

Fracturing has been observed in the bedrock layers, both in surface outcrops and in subsurface drill cores recovered from site investigations. Both low angle (less than 10 degrees from horizontal) and high angle (40 degrees on up to vertical) fractures have been reported. All three primary rock types (sandstones, siltstones, and mudstones) have had fractures reported. In addition, EPA believes that free-phase organic chemicals released from the source areas may have desiccated materials adjacent to fractures causing further opening of the fractures. The irregularity and heterogeneity of fracture distribution, interconnection and openness contribute to a relatively high degree of uncertainty regarding the large-scale hydraulic properties of the bedrock strata at the site, and therefore, high uncertainty regarding future waste migration rates and patterns.

Adjacent to the site, and associated with North Cri er Creek, is an unconsolidated alluvial deposit with thicknesses up to F feet. Alluvial borings completed during the second operable unit RI typica ly encountered a thin silt/clay zone at a depth of 10-15 feet, which in t rn was underlain by medium to coarse-grained silty sands. Bedrock unde lying the alluvium was found to be a fine-grained silty mudstone, with sor degree of weathering immediately beneath the alluvium.

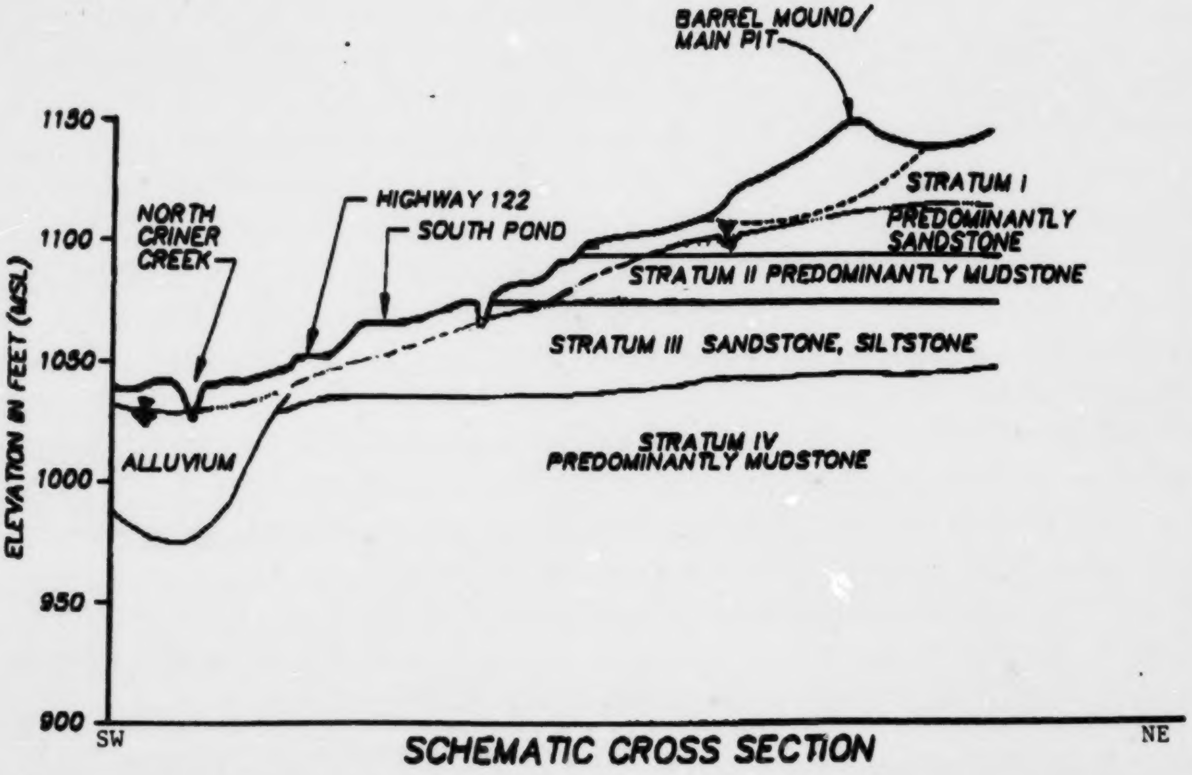

BARREL MOUND/
MAIN PIT
1150
1100
1050
1000
950
900
ELEVATION IN FEET (MSL)
NORTH
CRINER
CREEK
HIGHWAY 122
SOUTH POND
STRATUM I
PREDOMINANTLY
SANDSTONE
STRATUM II PREDOMINANTLY MUDSTONE
STRATUM III SANDSTONE, SILTSTONE
ALLUVIUM
STRATUM IV
PREDOMINANTLY MUDSTONE
SW
NE
SCHEMATIC CROSS SECTION

FIGURE 4-3

GEOLOGIC CROSS-SECTION
HARDAGE/CRINER SITE

4.1.3 Groundwater Hydrology

The geologic units described above, given their fractured and weathered conditions, have combined to form a hydrogeologic system as illustrated in Figure 4-4. This figure illustrates the hydrogeologic units at the site: (A) moderately permeable weathered shallow bedrock with general groundwater flow to the southwest into the alluvium of North Criner Creek (Stratum I-III and the top of Stratum IV, especially in the vicinity of the southwest alluvium); (B) a sequence of variably fractured siltstone and mudstone (the lower portions of Stratum IV); and (C) the North Criner Creek alluvium, a third hydrogeologic unit. The weathered zone and alluvial aquifer are the most permeable units at the site and, consequently, are the units most active in the local groundwater flow regime.

The water table across the site forms a continuous surface across Stratum I, II, and III, and is roughly parallel to the land surface as shown in Figure 4-4. The hydraulic conductivity reported for Stratum I through III ranges from about 2×10^{-7} cm/sec to about 1.5×10^{-3}. Flow in these units has a large horizontal component with a gradient of about 0.01 to 0.07. Lower and higher hydraulic conductivities correspond to an estimated average flow velocity of 18 to 180 feet per year, consistent with the known distribution distances and patterns of contaminants in groundwater at the site. Stratum II has a somewhat lower hydraulic conductivity than Stratum I or III.

Groundwater flow in Stratum I-III in the vicinity of the east farm ponds varies seasonally and is affected by surface water levels in the ponds and recharge to soils. It is generally accepted that the ponds form a discharge boundary for groundwater flow. However, monitoring during and after any remedial action will be required to assure that contaminants are not migrating eastward, beneath the ponds.

Alluvial deposits of North Criner Creek can be separated into upper and lower portions that act as a single unit hydraulically. Nested monitoring wells in the alluvium indicate a general upward gradient through these deposits, implying upward flow out of Stratum IV into the alluvium. Pumping tests indicated an overall effective permeability on the order of 5×10^{-3} cm/sec. Transmissivity values range greatly in the alluvium, however, the overall transmissivity is about 3200 to 3500 gpd/ft. Effective porosity ranges between 0.25 and 0.30.

Groundwater flow in the alluvium of North Criner Creek is generally toward the Creek, though skewed down-valley. Contaminants detected in the alluvial aquifer are also found in the source areas of the site. The concentration of total volatile organic compounds (which include toxic substances such as 1,2-dichloroethene and trichloroethene) are several hundred ppb in at least three alluvial aquifer wells. In general, North Criner Creek forms the discharge boundary to groundwater flow from the site, limiting migration of contaminants across the Creek.

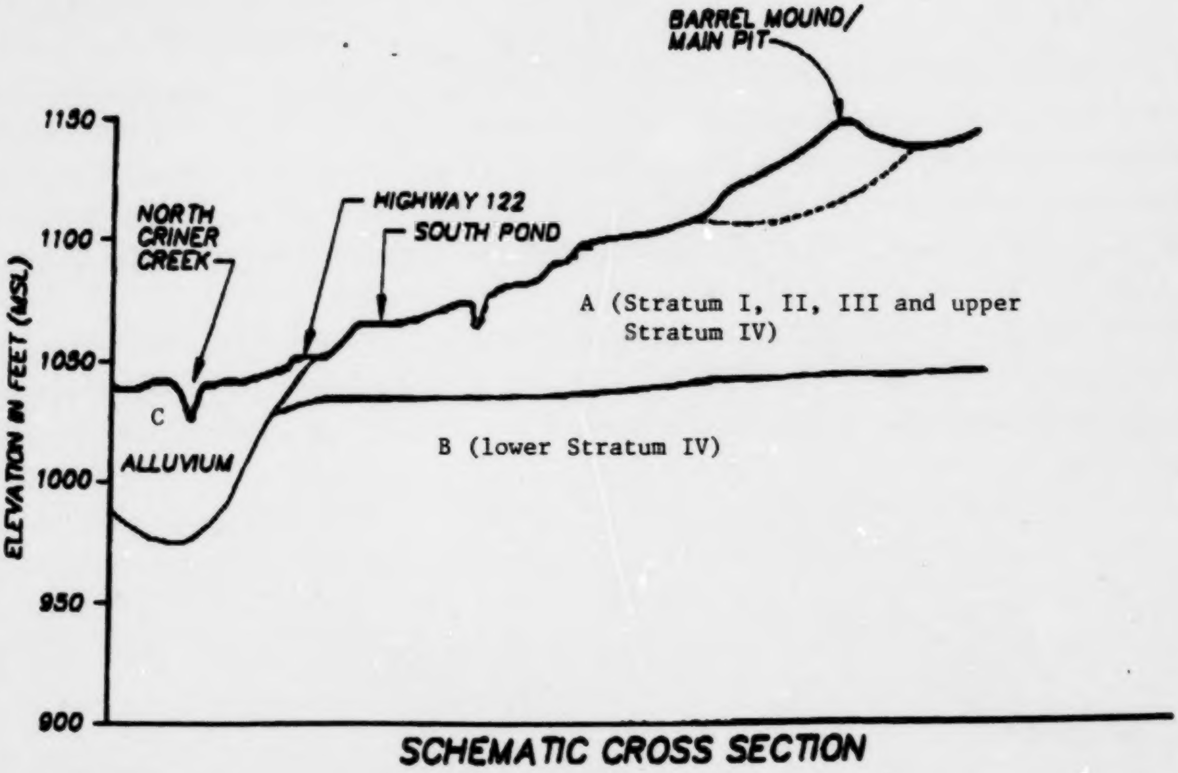

BARREL MOUND/
MAIN PIT
HIGHWAY 122
SOUTH POND
NORTH
CRINER
CREEK
1150
1100
1050
1000
950
900
ELEVATION IN FEET (MSL)
A (Stratum I, II, III and upper
Stratum IV)
C
ALLUVIUM
B (lower Stratum IV)
SCHEMATIC CROSS SECTION

FIGURE 4-4

HYDROGEOLOGIC CROSS-SECTION
HARDAGE/CRINER SITE

4.2 Site Contamination

During the site operations, approximately 21 million gallons of industrial wastes including acidic, caustic and corrosive wastes, many classified as carcinogenic, were disposed on the Hardage site. During and after the operations, waste liquids migrated downward from several unlined impoundments, principally the Main Pit, North Pit, and West Pond (mixing) areas and to a lesser extent from the Sludge Mound, and East Pond (mixing) areas, and random spills on the site. Presently, approximately 70 acres of groundwater on and adjacent to the site is contaminated by organic compounds. Groundwater contaminant plumes have migrated east and southwest of the site. Contamination has entered the North Criner Creek alluvium, and has recently had a low but measurable impact on surface water quality (August 7, 1989 sampling). Surface and shallow subsurface soils at and around the source areas are contaminated by low levels of metals. Approximately 278,000 cubic yards of highly contaminated material exists in the Main Pit, Barrel Mound and Sludge Mound which contains soil, sludge, waste liquid, and intact drummed waste.

4.2.1 Impact of Disposal Operations

During operation of the site, several potential sources of groundwater contamination existed. These were:

- Main pit/Barrel mound
- Sludge Mound
- North Pit
- West Pond (mixing) areas
- East Pond (mixing) areas
- Miscellaneous spills, drum leaks, etc.
- Contaminated runoff paths and south pond

Since liners were not constructed in any of these areas to limit waste seepage, and since the permeability of the soil profile and shallow bedrock is relatively uniform across the site, it is believed that those areas where waste liquids were impounded for the longest periods of time contributed most to groundwater contamination. The longer-term liquid storage and disposal areas were the Main Pit, Barrel Mound, Sludge Mound, West Pond, North Pit, and to some extent, the East Pond (see Figure 1-2). The remaining areas contributed lesser amounts of contaminants to groundwater contamination for reasons as follows:

- Miscellaneous Spills - these were due to the nature of operations. Although drums were occasionally stored on site, the typical practice was to immediately discharge or dump wastes into the pits upon receipt. Therefore, spills probably did not release large volumes of waste liquids.

- Runoff - No information exists to indicate any impoundments were breached, or liquid waste was directly released except for limited seeps. Rainfall presumably contacted wastes, dissolving contaminants and carrying them down slope from the source areas. However, the contaminants in runoff would be highly dilute, as compared to that in waste pits. In addition, any infiltration of runoff would be transient, as compared to the continuous release from pooled waste liquids such as those in the main pit.

4.2.2 Remaining Contaminant Sources

In addition to contaminants which have dissolved into groundwater beneath and adjacent to the site, several potent "sources" exist which will tend to release further contamination from the site. These sources are:

a) Main Pit/Barrel Mound
b) Sludge Mound;
c) Residual soil contamination in the North pit and immediately west of the main pit; and
d) NAPL in bedrock beneath the source areas.

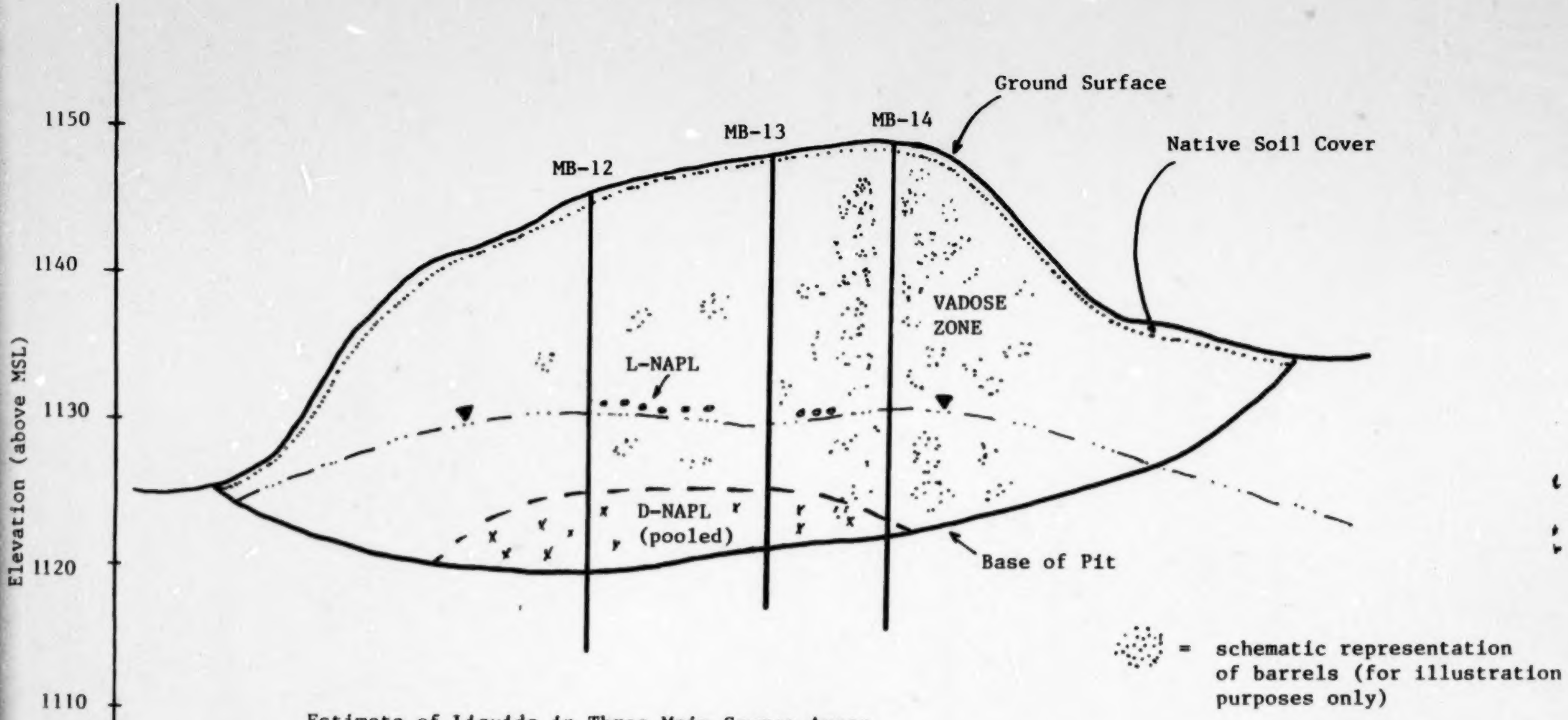
The content and character of these four sources is generally as follows:

a) Main Pit/Barrel Mound:
The Barrel Mound was built by random dumping of drums and the periodic spreading of soil to allow further drum dumping. As a result, the Barrel Mound is highly variable. Based on the history of disposal operations and data from three exploratory borings done in 1988, the mound consists of a two to three foot cover of native soils underlain by randomly oriented drums mixed with soils and waste sludges. At a depth of 5 to 10 feet, drilling yielded little data other than the depth to liquids, due to minimal core recovery. The liquids present at the base of the Barrel Mound appear to consist of a 6 inch layer of waste floating on water (L-NAPL or light non-aqueous phase liquids); 4 feet of water; and 4 feet of heavier than water wastes (D-NAPL or dense non-aqueous phase liquids) on the bedrock surface (see schematic illustration, Figure 4-5). The Barrel Mound would, due to the nature of its construction, be expected to have a large number of voids in and around drums. This expectation was supported by difficulties encountered in closing one boring (high grout take) and the inability to bail down waste liquid levels in two other borings. The other significant finding in the barrel mound borings was the apparent contamination of bedrock immediately underlying wastes.

At its southern end, the Barrel Mound grades into the Main Pit. The Main Pit is predominantly contaminated soil, however, concentrations of drums similar to those found in the Barrel Mound are present in about 1/3 of the main pit, particularly along the west bank. Locallized pools of waste, similar to that in the Barrel Mound, are likely to be present in the Main Pit. While exploratory borings did not encounter such pooled liquids, areas of drum concentrations, those areas where pooled liquids would most likely be present, were intentionally avoided in drilling.

FIGURE 4-5

MAIN PIT AND BARREL MOUND CROSS-SECTION


Elevation (above MSL)
1150
1140
1130
1120
1110
1100
MB-12
MB-13
MB-14
Ground Surface
Native Soil Cover
VADOSE ZONE
L-NAPL
D-NAPL (pooled)
Base of Pit
= schematic representation of barrels (for illustration purposes only)

Estimate of Liquids in Three Main Source Areas

Barrel Mound/Main Pit = (1.55 + 2.07 acres)	113,500	gallons (vadose zone)
	660,000	gallons (in drums)
	956,000	gallons (pooled liquids)
Sludge Mound = (1.72 acres)	58,000	gallons (vadose zone)
TOTAL	1,800,000	gallons

Approximately 113,500 gallons of liquid are present in the soils of the the Main Pit/Barrel Bound (vadose zone) which together total 3.62 acres. An estimated 18,000 drums are buried in these areas representing some 660,000 gallons of stored liquids. (This assumes that two-thirds of the drums may be full).

b) Sludge Mound:
The Sludge Mound consists of layers of contaminated soil, oil recycling residues, and styrene tar wastes. Borings in the Sludge Mound indicated pockets of moist "stringy" sludge in addition to the overall soils contamination.

Approximately 58,000 gallons of liquid are present in the Sludge Mound (totalling 1.72 acres) weakly held in soil pores under capillary forces.

c) Residual Soil Contamination:
The former North Pit is underlain by a number of pockets of contaminated soils and 50 to 80 drums buried in shallow trenches. Sediment in the drainage channel along the west side of the Main Pit has been heavily contaminated by waste seepage from the Main Pit to a depth of five to ten feet. Contaminated soils are also present in the west pond area.

d) NAPL in Bedrock:
Pure free-phase (NAPL) has been observed at three locations adjacent to the source areas (B-13, MW-6, and MW-2). These wastes are present both at the water table and in the deeper more competent sandstone (Stratum III). The NAPL tends to be several thousand times as contaminated as the surrounding groundwater. However, similar to an oil layer floating on water, the separate phase waste cannot fully dissolve into the water. In the subsurface, clean groundwater tends to pick up dissolved contaminants as it flows around and through the NAPL. In this manner, the NAPL acts as a potent source of continuing contamination within the normal groundwater flow regime. Pockets at and beneath the water table are in a position to readily contaminate the surrounding groundwater.

Liquid accumulations have created a pool of liquids at the bottom of the main source areas estimated to be 956,000 gallons (see Figure 4-5).

The Main Pit, Barrel Mound and Sludge Mound are the largest sources of potential further site contamination. Exploratory borings have indicated that these areas consist of 278,000 cubic yards of wastes. Chemical sampling has indicated that some 171,500 gallons (113,500 + 58,000) of volatile chemicals are suspended in the soil vadose zone. Pooled liquids and intact drums are estimated to total 1,616,000 gallons (660,000 + 956,000), although precise quantification of the volume is not possible.

Table 4-1 lists a number of EPA classified carcinogens detected in the source area characterization holes.

Table 4-1
CARCINOGENS[1] DETECTED IN THE SOURCE AREAS CHARACTERIZATION HOLES[2]

Compound	Class
2,4,6-trichlorophenol	B2
bis(2-chloroethyl)ether	B2
1,4-dichlorobenzene	B2
2,6-dinitrotoluene	B2
1,2-diphenylhydrazine	B2
isophorone	C
N-nitrosodiphenylamine	B2
bis(2-ethylhexyl)phthalate	B2
butyl benzyl phthalate	C
beno (a) anthracene	B2
benzene	A
1,2-dichloroethane	B2
1,1,2,2-tetrachloroethane	C
chloroform	B2
1,1-dichloroethene	C
methylene chloride	B2
tetrachloroethene	B2
trichloroethene	B2
PCB-1260	B2
toxaphene	B2
vinyl chloride	A
1,1,2-trichloroethane	C

---

[1] EPA classified carcinogens
Reference: USEPA, Health Effects Assessments Summary Tables, Second Quarter, 1989.

[2] Source USEPA (1985)

4.2.3 Pathways and Extent of Contamination

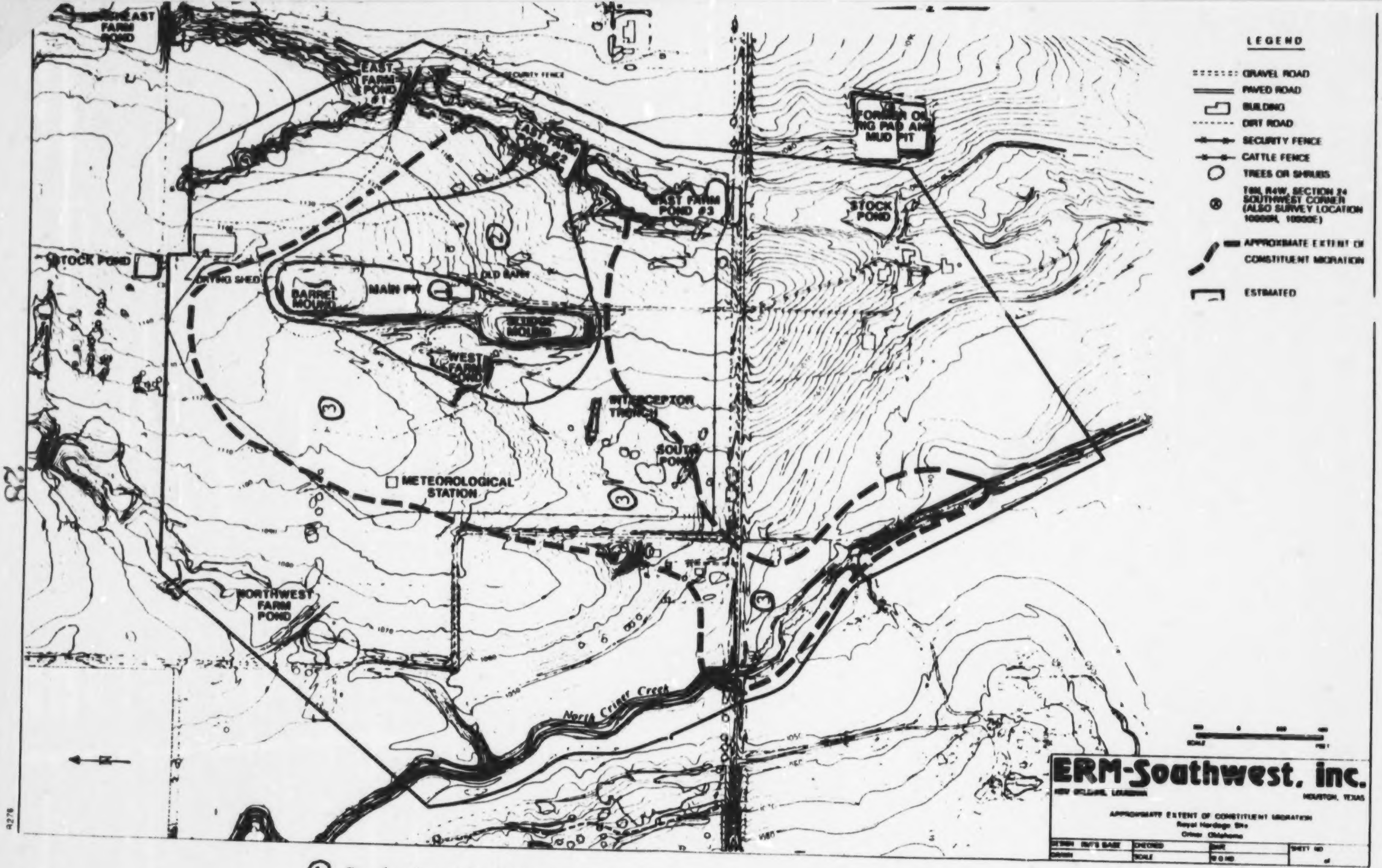
Contaminants have been transported on and away from the site by groundwater flow. Additional contaminants have also migrated from the source areas by way of surface water runoff; however, sampling data from wells in the alluvial aquifer indicate that groundwater flow, rather than surface water runoff, has been the predominant pathway for migration. Groundwater containing dissolved contaminants migrates vertically and southwestward toward the North Criner Creek alluvium and then upward into the alluvium and into the Creek.

Upward migration of groundwater from Stratum IV into the alluvium of North Criner Creek is documented by upward gradients in water levels of wells constructed at different depths in the alluvium. If contaminants are entering the alluvium primarily from the underlying bedrock (Stratum IV) and moving upward, contaminant concentrations should be higher in the lower part of the alluvial aquifer than in the upper portion. Conversely, if the contaminants are entering the alluvial aquifer primarily by percolating downward from the surface runoff water, the concentrations in the upper groundwater should be higher than in the lower groundwater. Sample analyses data from two different depths in the aquifer (wells MW-12S, -12M and MW-13S, -13M) show that the volatile organic chemical concentrations are greatest in the lowest portion of the aquifer, indicating that the contaminants have probably migrated through the bedrock from the site and into the lower alluvium (as opposed to the surface water pathway) (Reference, Affidavit of John B. Robertson).

During site operations, volatilization of chemicals into ambient air resulted in the release and transport chemicals offsite. This pathway was reduced with closure of the pits and capping of wastes. No residual effects have been identified, and none are believed to exist from air pathway transport due to the volatile organic nature of contaminants. At the present time and in the near future, transport of contaminated groundwater and discharge to surface waters are the only pathways of consequence. If the site is not properly remediated, contaminants will also eventually be released from the site in substantial quantities by erosion and runoff and to a lesser extent through slow volatilization to the atmosphere. As contaminants are exposed there would be an additional pathway for risk through direct contact with contaminated materials. The above pathways are discussed in further detail below.

Groundwater:

The principal pathway of contaminant migration at the Hardage site is through dissolved phase groundwater flow. Groundwater contamination emanating from the source areas extends approximately 600 to 800 feet to the east farm ponds. The contamination plume extends offsite to North Criner Creek, approximately 1600 feet. The plume in the alluvial aquifer is distorted, both parallel to and towards North Criner Creek. Overall, the groundwater plume underlies approximately 70 acres on and adjacent to the site (Figure 4-6, Area 3).


NORTHEAST FARM POND
EAST FARM POND #1
SECURITY FENCE
EAST FARM POND #2
EAST FARM POND #3
FORMER OIL RIG PAD AND MUD PIT
STOCK POND
STOCK POND
DRYING SHED
BARREL MOUND
MAIN PIT
OLD BARN
SLUDGE MOUND
WEST FARM POND
INTERCEPTOR TRENCH
SOUTH POND
METEOROLOGICAL STATION
NORTHWEST FARM POND
North Criner Creek
N
1
2
3
3
3
LEGEND
GRAVEL ROAD
PAVED ROAD
BUILDING
DIRT ROAD
SECURITY FENCE
CATTLE FENCE
TREES OR SHRUBS
T6N, R4W, SECTION 24 SOUTHWEST CORNER (ALSO SURVEY LOCATION 10000N, 10000E)
APPROXIMATE EXTENT OF CONSTITUENT MIGRATION
ESTIMATED
SCALE
FEET
ERM-Southwest, inc.
NEW ORLEANS, LOUISIANA
HOUSTON, TEXAS
APPROXIMATE EXTENT OF CONSTITUENT MIGRATION
Royal Hardage Site
Criner Oklahoma
DRAWN
CHECKED
DATE
SCALE
SHEET NO
of

① Predominantly NAPL Plume
② Semi-volatile Plume
③ Volatile Plume

FIGURE 4-6
APPROXIMATE EXTENT OF
GROUNDWATER CONTAMINATION

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best available copy.

The groundwater contaminant plume contains a wide variety of volatile organic chemicals which include toxic compounds such as 1,2-dichloroethene and trichloroethene. A summary of contaminants and their concentration for onsite wells is presented in Table 4-2. Beneath and immediately adjacent to the source areas (Figure 4-6, Area 1) volatile, semivolatile, and pesticide compounds are present at their highest levels, in some cases exceeding 25,000 ppb for volatile organics. At three locations NAPL has been encountered (MW-6, B-13, and MW-2). Additional pockets of NAPL are almost certainly present in other areas beneath the source areas, particularly at the Barrel Mound. A somewhat larger portion of the plume (Figure 4-6, Area 2) contains both volatile and semivolatile contaminants, but not NAPL. This, the "semi-volatile plume", extends over 600 feet eastward to where the plume discharges into the east farm ponds. To the southwest, the semi-volatile plume extends only about 200 feet (to well MW-45). Contamination by volatile organic chemicals (VOC) is most widespread and defines the extent of contamination. The VOC plume extends southeast into the alluvium of North Criner Creek (see Figures 4-6, Area 3). Contaminated groundwater flowing southwest through the onsite bedrock discharges to the alluvial aquifer. This discharge constitutes the source of continuing contamination in the alluvium (see Figures 4-4 and 4-7,. Average flow rates along this pathway have been estimated at 110 feet per year (Affidavit of John B. Robertson).

Discharge of Contaminated Groundwater to Surface Water:

Both the east farm ponds and North Criner Creek receive contaminants via discharge of groundwater to the surface waters. The contaminants entering North Criner Creek are chlorinated ethanes and chlorinated ethenes. Since these chemicals are volatile, natural processes rapidly strip volatiles from the surface waters, and release them to the air. Sampling of North Criner Creek has only most recently detected contamination (1-2 dichloroethene, 5 ppb and trichloroethene approximately 2 ppb), and supports the belief that the discharge of contaminated groundwater can have a measureable impact on surface water quality in the Creek.

Volatile chemicals also enter the east farm ponds. Sampling to date has not indicated the presence of volatiles; however, more persistent semivolatile chemicals are seeping into the southernmost east farm ponds and are impacting water quality in the immediate vicinity of the seeps. These compounds appear to be entering the farm pond due to seepage of NAPL along the bedrock surface. Dilution of this seepage is presently occuring so that impacts on water quality of the pond have not been measureable.

TABLE 4-2

Comparison of the Groundwater Data from the Alluvial Wells Adjacent to the Hardage/Criner Site with Maximum Contaminant Levels Set by the Safe Drinking Water Act

Contaminant	MCL ug/l	Greatest Concentration ug/l	Total Detections	Total Detections >MCL	Greatest "Quantitative" Concentration ug/l	Total "Quantitative" Detections	Total "Quantitative" Detections >MCL
Trihalomethanes	100	8.7	7	0	8.7	7	0
1,2-Dichloroethane	5	240	13	8	240	13	8
1,1,1-Trichloroethane	200	120	26	0	120	26	0
Vinyl chloride	2	4.5	4	2	4.5	4	2
1,1-Dichloroethene	7	57	27	20	57	27	20
trans-1,2-Dichloroethene	70	370	25	13	370	25	13
Trichloroethene	5	290	29	28	290	29	28
Tetrachloroethene	5	29	17	11	29	17	11
Benzene	5	1	1	0	1	1	0
PCBs	5	4.4	1	0	4.4	1	0
Arsenic	50	19	19	0	12	18	0
Barium	1000	990	52	0	606	41	0
Cadmium	10	11	4	1	9	1	0
Chromium	50	129	6	2	37	2	0
Fluoride	4000	380	21	0	380	21	0
Lead	50	28	7	0	28	4	0
Mercury	2	0.6	2	0	0.6	2	0
Nitrate	10000	6100	20	0	6100	20	0
Selenium	10	76	14	4	76	12	4
Silver	50	6	2	0	6	2	0

References:

K. W. Brown & Associates, Inc. August 9, 1989. Groundwater Contamination at the Hardage Site: Organic Data Tabulated by Well.

K. W. Brown & Associates, Inc. August 9, 1989. Groundwater Contamination at the Hardage Site: Inorganic Data Tabulated by Well.

TABLE 4-2 (continued)

A Comparison of the Groundwater Data at the Hardage/Criner Site with Maximum Contaminant Levels Set by the Safe Drinking Water Act

Contaminant	MCL ug/l	Greatest Concentration ug/l	Total Detections	Total Detections >MCL	Greatest "Quantitative" Concentration ug/l	Total "Quantitative" Detections	Total "Quantitative" Detections >MCL
Trihalomethanes	100	154900	74	18	154900	60	15
Carbon tetrachloride	5	4	1	0	0	0	0
1,2-Dichloroethane	5	350000	89	76	350000	76	65
1,1,1-Trichloroethane	200	32000	110	26	32000	85	23
Vinyl chloride	2	10000	37	31	10000	33	27
1,1-Dichloroethane	7	8200	119	95	8200	97	76
trans-1,2-Dichloroethene	70	9500	114	64	9500	91	52
Trichloroethene	5	11000	125	107	11000	100	82
Tetrachloroethene	5	28000	92	68	28000	74	55
Benzene	5	420	24	9	420	21	7
1,2-Dichlorobenzene	75	2500	20	5	2500	16	2
PCBs	5	1000	7	6	1000	6	6
Arsenic	50	26	56	0	26	52	0
Barium	1000	3300	204	202	712	138	0
Cadmium	10	75	20	9	75	14	7
Chromium	50	1180	52	17	1180	26	8
Fluoride	4000	11000	76	1	11000	76	1
Lead	50	94	22	1	94	9	1
Mercury	2	1.1	12	0	0.7	9	0
Nitrate	10000	7000	71	0	7000	71	0
Selenium	10	76	53	13	76	34	8
Silver	50	17	10	0	17	9	0

References:

K. W. Brown & Associates, Inc. August 9, 1989. Groundwater Contamination at the Hardage Site: Organic Data Tabulated by Well.

K. W. Brown & Associates, Inc. August 9, 1989. Groundwater Contamination at the Hardage Site: Inorganic Data Tabulated by Well.

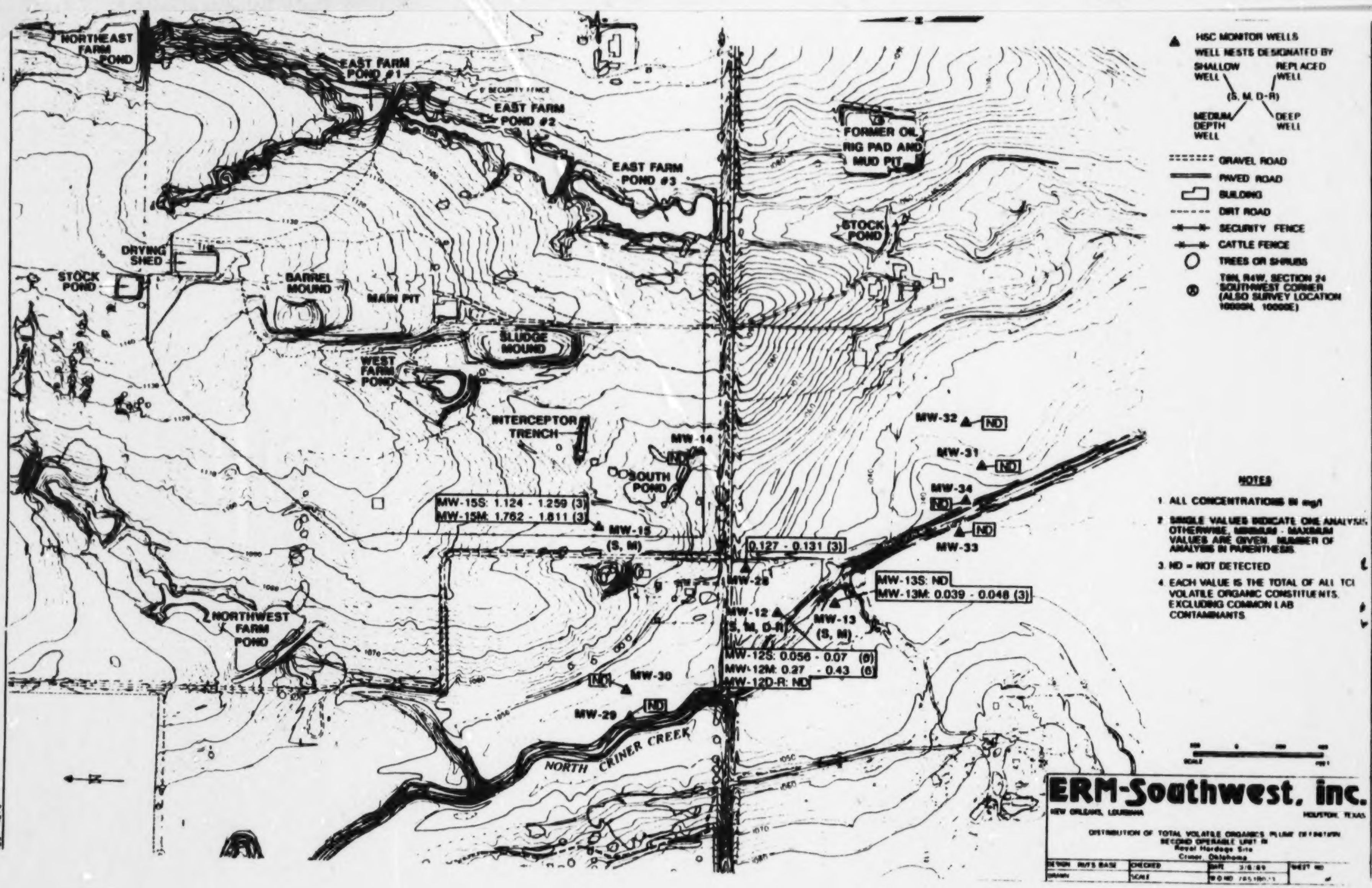
NORTHEAST FARM POND
EAST FARM POND #1
SECURITY FENCE
EAST FARM POND #2
EAST FARM POND #3
FORMER OIL RIG PAD AND MUD PIT
STOCK POND
DRYING SHED
STOCK POND
BARREL MOUND
MAIN PIT
SLUDGE MOUND
WEST FARM POND
INTERCEPTOR TRENCH
MW-14
SOUTH POND
MW-32 ND
MW-31 ND
MW-34 ND
MW-33 ND
MW-15S: 1.124 - 1.259 (3)
MW-15M: 1.762 - 1.811 (3)
MW-15 (S, M)
0.127 - 0.131 (3)
MW-28
MW-13S: ND
MW-13M: 0.039 - 0.048 (3)
MW-12 (S, M, D-R)
MW-13 (S, M)
MW-12S: 0.056 - 0.07 (6)
MW-12M: 0.27 - 0.43 (6)
MW-12D-R: ND
NORTHWEST FARM POND
MW-30 ND
MW-29 ND
NORTH CRINER CREEK
HSC MONITOR WELLS
WELL NESTS DESIGNATED BY
SHALLOW WELL
REPLACED WELL
(S, M, D-R)
MEDIUM DEPTH WELL
DEEP WELL
GRAVEL ROAD
PAVED ROAD
BUILDING
DIRT ROAD
SECURITY FENCE
CATTLE FENCE
TREES OR SHRUBS
T9N, R4W, SECTION 24 SOUTHWEST CORNER (ALSO SURVEY LOCATION 10000N, 10000E)
NOTES
1 ALL CONCENTRATIONS IN mg/l
2 SINGLE VALUES INDICATE ONE ANALYSIS OTHERWISE, MINIMUM - MAXIMUM VALUES ARE GIVEN. NUMBER OF ANALYSIS IN PARENTHESIS
3 ND = NOT DETECTED
4 EACH VALUE IS THE TOTAL OF ALL TCL VOLATILE ORGANIC CONSTITUENTS, EXCLUDING COMMON LAB CONTAMINANTS
SCALE
FEET
ERM-Southwest, inc.
NEW ORLEANS, LOUISIANA
HOUSTON, TEXAS
DISTRIBUTION OF TOTAL VOLATILE ORGANICS PLUME DEFINITION
SECOND OPERABLE UNIT RI
Royal Hardage Site
Criner, Oklahoma
DESIGN RI/FS BASE
CHECKED
DATE 3/6/89
SHEET NO
DRAWN
SCALE
W.O. NO. 785.100.11

FIGURE 4-7

DISTRIBUTION OF TOTAL VOLATILE ORGANICS
IN STRATUM III AND THE ALLUVIUM

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Surface Water Runoff and Sediment Transport:

Surface water runoff and sediment transport will constitute substantial pathways for contaminant transport from the site over the long-term if the site is left unremediated. Vegetation over much of the site, including the source areas, is sparse due to the removal of the topsoil in the course of site operations. The lack of vegetation contributes to soil erosion. In addition, the final contour of the waste mounds is not conducive to long-term stability. Leachate seeps from the western side of the waste mounds are common in the wet, spring months. Rainfall runoff tends to spread this leachate downslope, resulting in visible contamination as far southwest as the existing interceptor trench.

4.2.4 Future Contaminant Migration

Left unremediated, contaminants will continue to migrate off of the site and spread on the site by the following general pathways:

1. expansion of the plumes of contaminated groundwater;
2. leakage and spread of waste liquids from the Barrel Mound and Main Pit, which will in turn continue to feed the plumes on contaminated groundwater;
3. dissolution of contaminants by groundwater infiltrating through the the Sludge Mound, Main Pit, Barrel Mound, and areas of residual contamination; and
4. transport of wastes and contaminated soils from the Main Pit, Barrel Mound, Sludge Mound and adjacent mixing areas via erosion and runoff.
5. long-term low-level releases of volatile compounds to the atmosphere

The groundwater contaminant plumes present at the Hardage site have developed over the 17 years since operations started at the Hardage site. Left unremediated, plumes of contamination in the vicinity of both the east farm ponds and North Criner Creek will expand. Modelling of the southwest alluvial plume in the Remedy Report (EPA, 1989) predicted a gradual expansion approaching 2000' (with dilution) even with the source of contamination to the alluvium cut off. Without source control and groundwater remedial actions, the southwest alluvial contaminant plume would certainly continue to expand southeastward, parallel to the stream. The plume near the east farm ponds may expand eastward beneath the ponds, although this is uncertain due to remaining questions about groundwater and surface water interaction acting as a barrier to migration around the ponds.

Waste liquids in the Barrel Mound and Main Pit will continue to migrate into the surrounding bedrock and groundwater in accordance with the conceptual model illustrated in Figure 4-5. Liquids in the Barrel Mound are released as drums of waste liquid corrode and as liquids drain from saturated soils (under gravity and consolidation). These liquids drain downward through the permeable mounds and accumulate on the less permeable sandstone and siltstone bedrock surface at the base of the pit. This pool of waste liquids tends to drain downward under gravity through pores and fractures in the shallow bedrock. As the liquids move downward some 10-15 feet below the base of these pits, they encounter a less permeable bedrock horizon and tend to spread out across the upper surface of that horizon and migrate with a lateral component, as seen at locations MW-2 and MW-6.

In their present condition, the source areas are susceptible to infiltration of rainfall. As this water percolates downward through the source materials, it dissolves contaminants and carries them downward to the groundwater system. This is a potential continuing source of release on the site.

Over time, erosion of contaminated soils is expected to increase to a point where substantial offsite releases occur via erosion and runoff.

5.0 SITE RISKS

The Hardage site received hazardous wastes that are either known or suspected carcinogens such as vinyl chloride and benzene. Table 4-1 gives a more complete list of carcinogens found at the site. Other compounds either are or are believed to be acutely toxic or capable of causing damage to specific organs. Some of these compounds also bio-accumulate in plant, animal, and human tissues. The Hardage Site was permitted to receive all types of industrial and hazardous wastes except radioactive wastes. Table 2-1 lists some of the wastes known to have been received at the site.

There are four primary ways humans can be exposed to the hazardous wastes at the Hardage site. The first and most important of these is exposure to contaminated groundwater. The groundwater at the Hardage site is contaminated with waste migrating from the source areas into the bedrock and alluvial groundwater systems. Not only is the groundwater under the site contaminated with these hazardous wastes, but the contamination has spread beyond the site to the south and has already forced local residents to stop using their water wells.

The contaminated water wells are located in the North Criner Creek Alluvium which lies below the Creek south of the site. This aquifer is contaminated with the chemicals exceeding the standards for consumption of drinking water as set under the Safe Drinking Water Act that are also given under the column titled MCL in Table 4-2.

As Table 4-2 shows, eight of these contaminants are already above the limits. The nearest of the contaminated residential wells is the old Corley well. The old Corley well is located approximately 500 feet southwest of the site. Estimates of the risk of cancer from lifetime use of residential water contaminated at the level of the old Corley well range from 0.0007 (seven per ten thousand) to 0.006 (six per thousand) far above the one in one million level commonly used as an acceptable risk. These estimates were arrived at using average concentrations of contaminants in the old Corley well and making assumptions about standard ingestion of water, inhalation exposures and dermal exposures from household use.

With the North Criner Creek alluvium already contaminated, one of the goals of the cleanup will be to restore the groundwater to a useable condition. The standards used to judge the effectiveness of the cleanup alternatives for groundwater will be the Maximum Contaminant Levels set under the Safe Drinking Water Act (MCLs). The effect of the proposed cleanup plans can be compared through their effects on the concentration of contaminants in the North Criner Creek alluvium. The proposed EPA remedies would result in lower concentrations of contaminants in groundwater in the alluvium of North Criner Creek through removal and destruction of contaminants at the source and interception and treatment of groundwater by trenches. While it is not possible to accurately assess how long the source areas would continue to bleed contaminants into the groundwater systems, it does not require and expert to conclude that if the HSC remedy leaves 10 or 100 times more of the most problematic waste liquids in the site than EPA's remedy, then the long-term duration of the EPA remedy would be shorter. The EPA remedy would therefore attain MCLs more quickly than the HSC remedy.

Direct contact with wastes on the surface of the site also poses hazards; however, the health risk is highly variable depending upon area of exposed waste and level of human traffic and has not been quantified. Human traffic on the site is minimal; but cattle did occasionally graze on the site. Contamination of the food-chain (for example beef and milk from cattle eating contaminated grass) by lead, chromium, pesticides, and PCBs on the surface of the site poses long-term hazards. This concern prompted construction of a fence to keep cattle and people off of the source areas. Certain compounds such as pesticides and PCBs have the ability to bioconcentrate through successively higher levels of the food chain (EPA, 1985a).

Inhalation of volatiles and concentrated airborne particulates on and possibly adjacent to the site may also pose long-term hazards if the site remains unremediated, but again this risk is highly variable depending upon the quantity of exposed contamination.

6.0 DESCRIPTION OF ALTERNATIVES

A large number of remedial alternatives have been formulated to address part or all of the Hardage site. As discussed in Section 3, the site has been considered as two "operable units". Source Control measures were considered by EPA in a 1986 FS. In November 1986, EPA issued a ROD which selected a Source Control remedy with incineration of liquid wastes and stabilization and containment of solids in a new landfill to be built on-site. HSC objected to the selection of this Source Control remedy and proposed an alternate Source Control remedy in December 1986 which called for in-place containment of the waste source areas by a cut-off wall and groundwater pumping. HSC declined to implement the EPA selected remedy which resulted in litigation in 1986. EPA maintained that the remedy selected in the 1986 ROD was technically sound and completed the Source Control Remedial Design in 1988. In 1987, HSC signed a partial Consent Degree with EPA for the conduct of an RI/FS for groundwater (Management of Migration). In May 1989 HSC, pursuant to the Consent Decree, submitted a draft FS on Management of Migration to EPA for review and approval.

During conduct and preparation of the groundwater RI/FS, uncertainty arose over the impact of RCRA Land Disposal Restrictions on the EPA selected Source Control remedy. To alleviate this uncertainty, EPA undertook consideration of an alternative Source Control remedy based upon the new technology of in-situ soil vapor extraction. Evaluation of soil vapor extraction in conjunction with alternative presented in the groundwater FS resulted in consideration of alternatives addressing the entire site in contrast to the original Operable Unit approach. On June 30, 1989, the United States advised the District Court of EPA's decision to consider a comprehensive site remedy.

On July 6th and in greater detail on October 13, 1989 the defendants presented to the court their plan to further define an additional remedial alternative. This, the HSC alternative, was similar to EPA's alternative except that the HSC plan did not include soil vapor extraction, enhanced recovery of containerized liquids, or the shallow waste liquid recovery trench proposed by EPA.

Previous and new alternatives for the control of the contaminant sources are summarized below in Section 6.1. Alternatives for groundwater as contained in the groundwater FS are summarized in Section 6.2. Common monitoring and support components for Groundwater and Source Control alternatives are listed in Section 6.3. Finally, Source Control and Groundwater alternatives are combined and summarized in Section 6.4.

6.1 Alternative Source Control Components

A number of alternatives were considered for remediation of the Source Control areas prior to the 1986 ROD. These can be seen in more detail in the 1986 ROD in Appendix F, along with evaluation criteria for remedy selection. Those remedies which were considered fell into four basic categories: no action; disposal onsite in a landfill (the EPA selected remedy in the 1986 ROD); containment of wastes in place (the HSC counter proposal of a cut-off wall); and incineration (also considered in the 1986 ROD). The following four sections summarize each of these categories.

6.1.1 No action. As the title implies, no work would be done to mitigate hazards from the site. The alternate water supply, security fence, and site stability measures would not be maintained.

6.1.2 Onsite Landfill (EPA 1986 ROD Remedy). The source areas would be excavated and separated for treatment. Organic liquids would be bulked and shipped offsite for thermal treatment at a permitted facility. Inorganic liquids would be treated and discharged to an onsite impoundment for evaporation. Solids would be stabilized by blending with 8-10% cement kiln dust and placed in a new double lined landfill cell constructed on-site in accordance with the Minimum Technology Requirements (MTR) of RCRA. The 1986 estimate of most probable cost was 70 million dollars.

6.1.3 Containment of wastes, Cap and Cut-off wall (HSC Proposal). A plastic cement "cut-off" wall would be constructed in panels so as to encircle the source areas. This wall would range from 70 to 130 feet in depth and, at its base, key 10 to 20 feet into the low permeability siltstone and mudstone of Stratum IV. Wells would be drilled through the Source areas and completed in the bedrock within the periphery of the wall. The water and wastes would be pumped from these recovery wells in an effort to induce a hydraulic gradient inward through the wall and prevent the outward migration of contaminants. Pumping would be conducted indefinitely.

Vertical waste liquid extraction wells would be drilled into the Barrel Mound and pumped in an effort to remove pooled liquid for treatment. In addition, lateral drains would be drilled from the west into the base of the Barrel Mound. These drains would slope slightly downward out of the mound to allow free drainage of waste liquids and groundwater from the Barrel Mound over time.

An effort would be made to speed consolidation of the Barrel Mound by placing a 20 foot thick soil layer as a surcharge for a period of 6 months to a year. After removal of the surcharge, a MTR cap would be installed over the source areas. The most probable cost estimate was 25 million dollars.

6.1.4 Incineration (EPA Proposal in 1986 ROD). The source areas would be excavated. Wastes would be incinerated in a kiln constructed onsite or at a commercial incinerator offsite. The ash would still contain metals and until it could be proven otherwise through de-listing, would require disposal as a hazardous waste. Estimates in 1986 for cost of incineration ranged from 133 to 374 million dollars.

The no action alternative was eliminated from consideration early as not being protective of human health or the environment due to continued vertical and lateral migration source area wastes offsite. Containment of the contamination in place was eliminated due concerns over continued migration of the contamination, doubts that containment techniques such as slurry walls could be installed effectively, and concerns relating to merely containing the sources of contamination rather than actively remediating them to achieve a permanent reduction in their volume, toxicity, or mobility.

The alternatives that remained were onsite disposal and incineration. The onsite landfill alternative was eventually selected as providing a degree of protection to human health and the environment similar to that which could be achieved with complete incineration, but which could be carried out in a shorter time and at a reduced cost. A more detailed comparison is given in the 1986 ROD in Appendix F. With this background, onsite disposal was selected in the 1986 ROD.

The new alternative for Source Control in the October 1989 Proposed Plan contained components for a new approach to Source Control. These components are as follows:

6.1.5 Liquid Extraction Wells

A system of vertical extraction wells would be installed throughout the three main source areas. The wells would be used for extracting free liquids that are found in the source areas, and liquids that would be released from the drums as a result of the lancing procedure described below, should it be used. The wells could also be used as part of the soil vapor extraction process described below.

An estimated approximately 956,000 gallons of aqueous and nonaqueous liquids presently reside in the saturated portions of the source areas. The quantity of residual liquids trapped within the unsaturated portion of the source areas is estimated as at least 170,000 gallons.

Additional liquids are likely to be found in drums buried in the source areas. Assuming that one third of the 18,000 drums estimated to be in the Main Pit/Barrel Mound contain organic liquids, an additional 660,000 gallons of liquids may be present that require removal and offsite disposal.

The liquids pumping operation is not expected to remove all of the free fluid found within the source areas due to localized pooling between wells, nor will it address the liquids residing in the unsaturated zone.

The nonaqueous-phase liquids removed from the extraction wells and trenches will be sent to a hazardous waste treatment, storage, and disposal (TSD) facility for incineration.

6.1.6 In-Place Drum Lancing

One method considered to assist in the removal of the liquids remaining in the buried drums was to lance the drums in place. The lancing process would release the liquids for subsequent removal by the wells or through the soil vapor extraction process (see Figure 6-1).

The lancing effort would be accomplished using commercially available construction equipment capable of driving solid spark-resistant Cu-Be rods to subsurface depths greater than 40 feet. The lancing would take place throughout the Barrel Mound and in areas of significant concentration of drums in the Main Pit. Magnetometer data highlighting areas of drum concentrations would be used to select appropriate areas in the Main Pit for lancing.

The lances would be advanced to the bottom of each target area at a nominal triangular spacing of 22 inches. The released liquids would be collected and removed via the extraction wells, a U-shaped trench (described later), or the soil vapor extraction system (described later).

The progress of the lancing operations would be controlled by monitoring the rise of fluid levels in nearby extraction wells. The effort would be made to prevent the accumulation of fluids to greater levels than those that currently exist in the source mounds. Non-aqueous phase liquids (NAPL) released by the lancing process and removed in the liquid extraction system would be sent to a TSD facility for treatment and disposal.

While lancing was considered as an option for the removal of drummed liquids, excavation of drums has several advantages over lancing for the removal of liquids. These include the assurance that all liquids are removed and the elimination of the introduction of additional liquids to the vadose zone on the short-term.

6.1.7 Drum Excavation

Liquids in drums from the Barrel Mound and the west side of the Main Pit can be removed from the source areas by excavating the drums as originally intended in the 1986 ROD instead of performing drum lancing. The excavation option would remove free liquids directly from the surface and from any drummed liquids in the source areas by direct removal. It is expected that excavation, utilized successfully at a number of other sites, would be more efficient than lancing in removing free and containerized liquids in the Main Pit/Barrel Mound. Figure 6-2 indicates areas that would be targeted for drum excavation. Drums that are removed from the source areas would be staged for sampling and consolidation with similar wastes. Drummed organic liquids would be consolidated for offsite treatment and disposal. The liquids would be transported to a hazardous waste treatment, storage and disposal (TSD) facility for incineration. Aqueous liquids would be treated onsite by the groundwater treatment facility. Any drums containing solids, or having solid residues in them after liquids are removed would be placed back into the source areas.

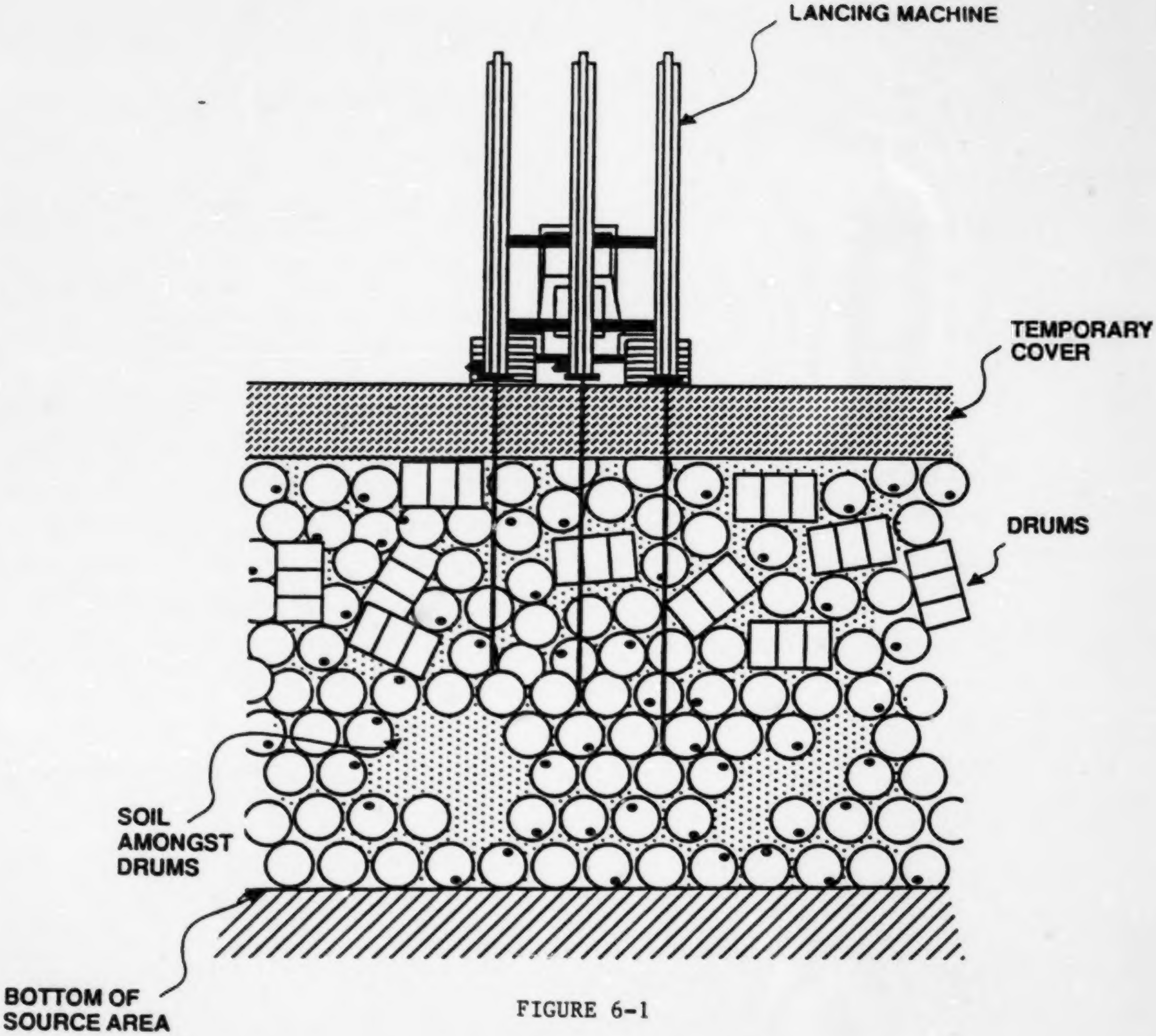
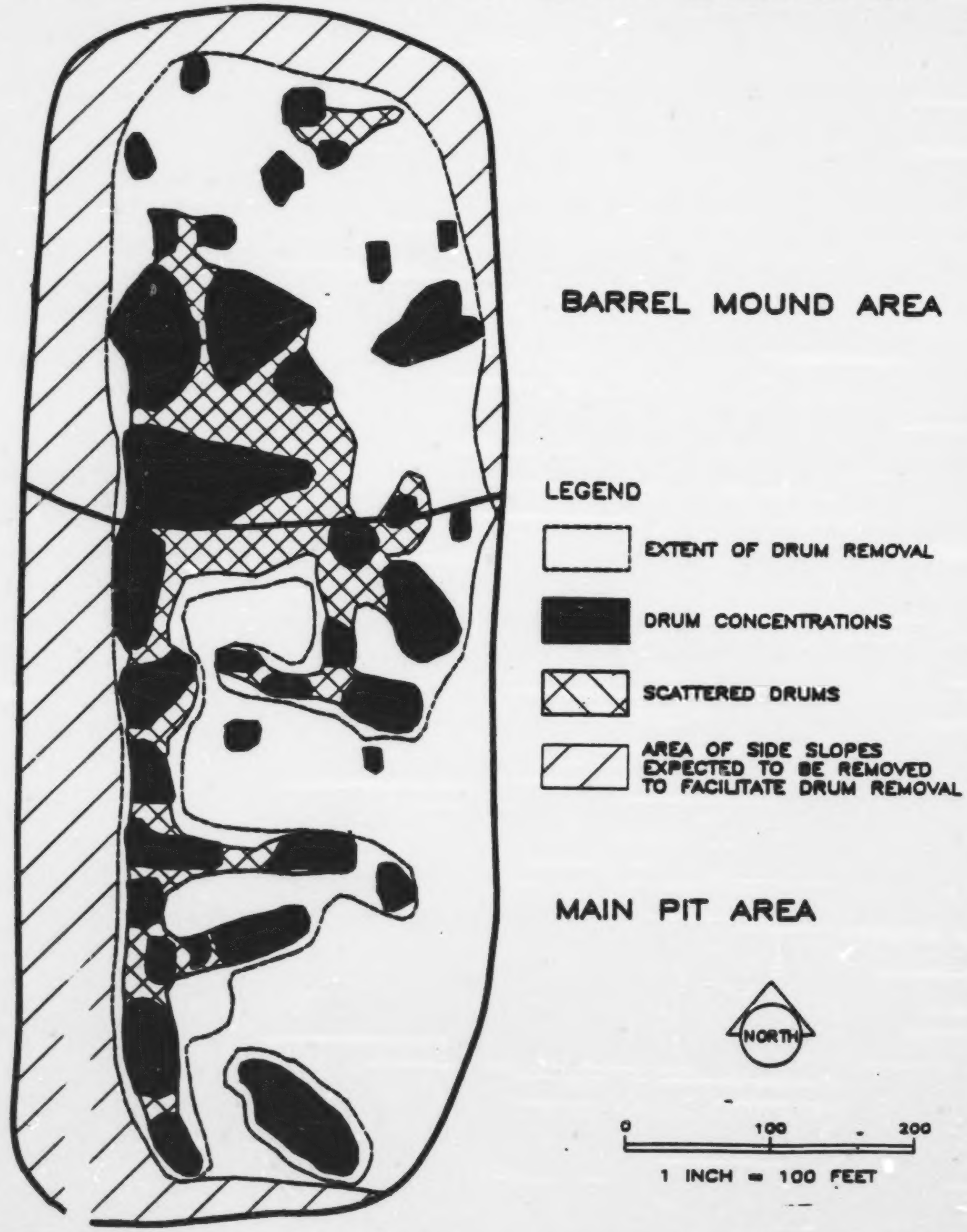

LANCING MACHINE
TEMPORARY COVER
DRUMS
SOIL AMONGST DRUMS
BOTTOM OF SOURCE AREA

FIGURE 6-1

CONCEPTUAL OPERATION OF DRUM LANCING

FIGURE 6-2
AREAS TARGETED FOR DRUM EXCAVATION


BARREL MOUND AREA
LEGEND
EXTENT OF DRUM REMOVAL
DRUM CONCENTRATIONS
SCATTERED DRUMS
AREA OF SIDE SLOPES EXPECTED TO BE REMOVED TO FACILITATE DRUM REMOVAL
MAIN PIT AREA
NORTH
0
100
200
1 INCH = 100 FEET

6.1.8 Excavation of Wastes in Adjacent Areas

Contaminated surface soils and waste materials located away from the source areas will be excavated and transported to the source areas. These materials will be consolidated under a temporary cap for soil vapor extraction along with trench excavation materials and other materials generated during implementation of the remedy. The greatest concentration of contaminated soils and wastes away from the source areas occurs in the North Pit area, where up to 80 drums of wastes as well as contaminated soils are believed to be buried, and in the West and East Pond Areas (see Figure 1-2).

If contaminated water or liquid wastes are encountered in these drums, they will be treated in the groundwater treatment facility to surface water discharge standards, or taken offsite for disposal, whichever is appropriate. The contaminated solids and soils will be remediated as part of the overall remediation program, once they are placed within the source areas and capped.

6.1.9 Soil Vapor Extraction and Treatment

Soil vapor extraction would be conducted in the three main source areas as a means to further capture and destroy the liquids present. Soil vapor extraction is expected to remove a large volume of the highly toxic and mobile volatile organic compounds present in the source areas. The soil vapor extraction systems would consist of a network of extraction wells screened in the contaminated (vadose) zone of the Main Pit/Barrel Mound and Sludge Mound. The dual-purpose extraction wells installed to remove liquids would be used as part of the vapor extraction system.

The liquids pumping operation is not expected to remove 100 percent of the liquids present. Numerous field studies have shown that in excess of 40 percent of the available liquids may remain trapped in the unsaturated zone following gravity drainage and pumping efforts. While not readily amenable to pumping, these residual liquids are subject to further removal by vapor extraction.

Soil vapor extraction works by drawing air through areas containing contamination thereby creating a vacuum in the source areas (see Figure 6-3). This, in turn results in a high evaporation rate of volatile and semi-volatile organic compounds, including significant quantities of toxic and carcinogenic contaminants that are in contact with groundwater and atmosphere. Such contaminants evaporate into the air drawn into the mounds. The contaminated air is then extracted through air extraction wells and is treated onsite to destroy the contamination.

If lancing is used, vapor extraction is also expected to remove a significant quantity of the liquids that remain trapped in the drums.

If there are pockets or low spots in the mounds between the liquid extraction wells, the vapor extraction process will further aid in the removal of liquids that cannot migrate towards the extraction wells.

The air stream and vapors removed by the soil vapor extraction system will be treated using the Best Available Control Technology for thermal destruction

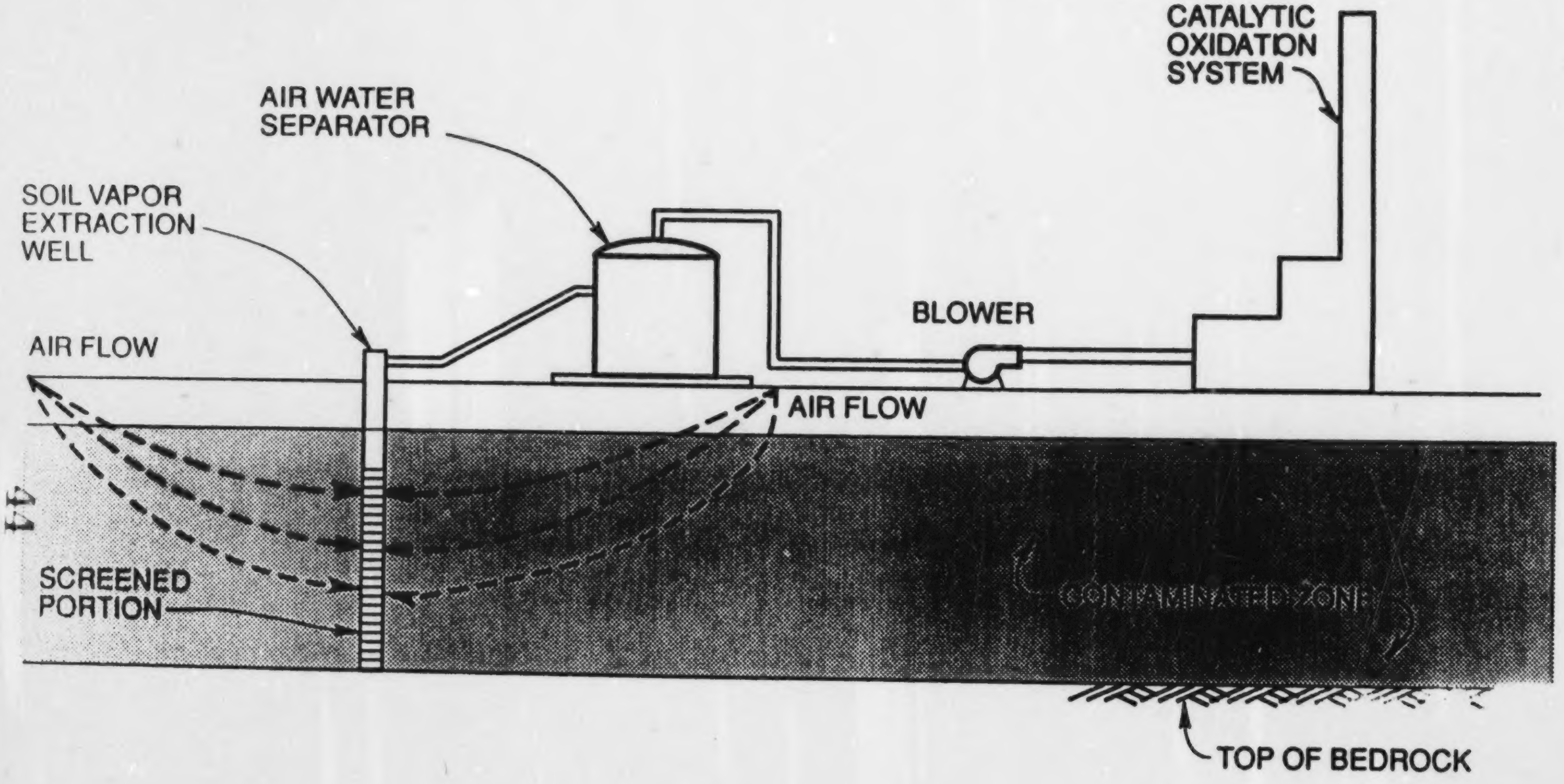

CATALYTIC OXIDATION SYSTEM
AIR WATER SEPARATOR
SOIL VAPOR EXTRACTION WELL
BLOWER
AIR FLOW
AIR FLOW
SCREENED PORTION
CONTAMINATED ZONE
TOP OF BEDROCK

FIGURE 6-3

SOIL VAPOR EXTRACTION--
SCHEMATIC

of toxic vapors prior to discharge to the atmosphere. Vapors generated by the groundwater treatment system will also be destroyed in this thermal treatment system.

6.1.10 Source Area Capping

Two types of source area capping are planned for the site. A temporary cover would be installed during remediation activities, and a permanent RCRA-compliant cap would be installed once soil vapor extraction and liquid extraction activities are complete. The temporary cover will consist of compacted, minimum 1-foot thick, low-permeability soil with vegetation to minimize erosion. Repairs will be made as needed to compensate for damage from settlement and erosion.

Permanent RCRA-cap installation would be initiated once the drummed liquids are removed, soil vapor extraction has been completed, and the liquid extraction wells have been decomissioned. The cap will be location over the Main Pit, Barrel Mound and Sludge Mound areas as illustrated in Figure 6-4.

Section 6.2 Groundwater Remediation Objectives and Alternative Groundwater Components

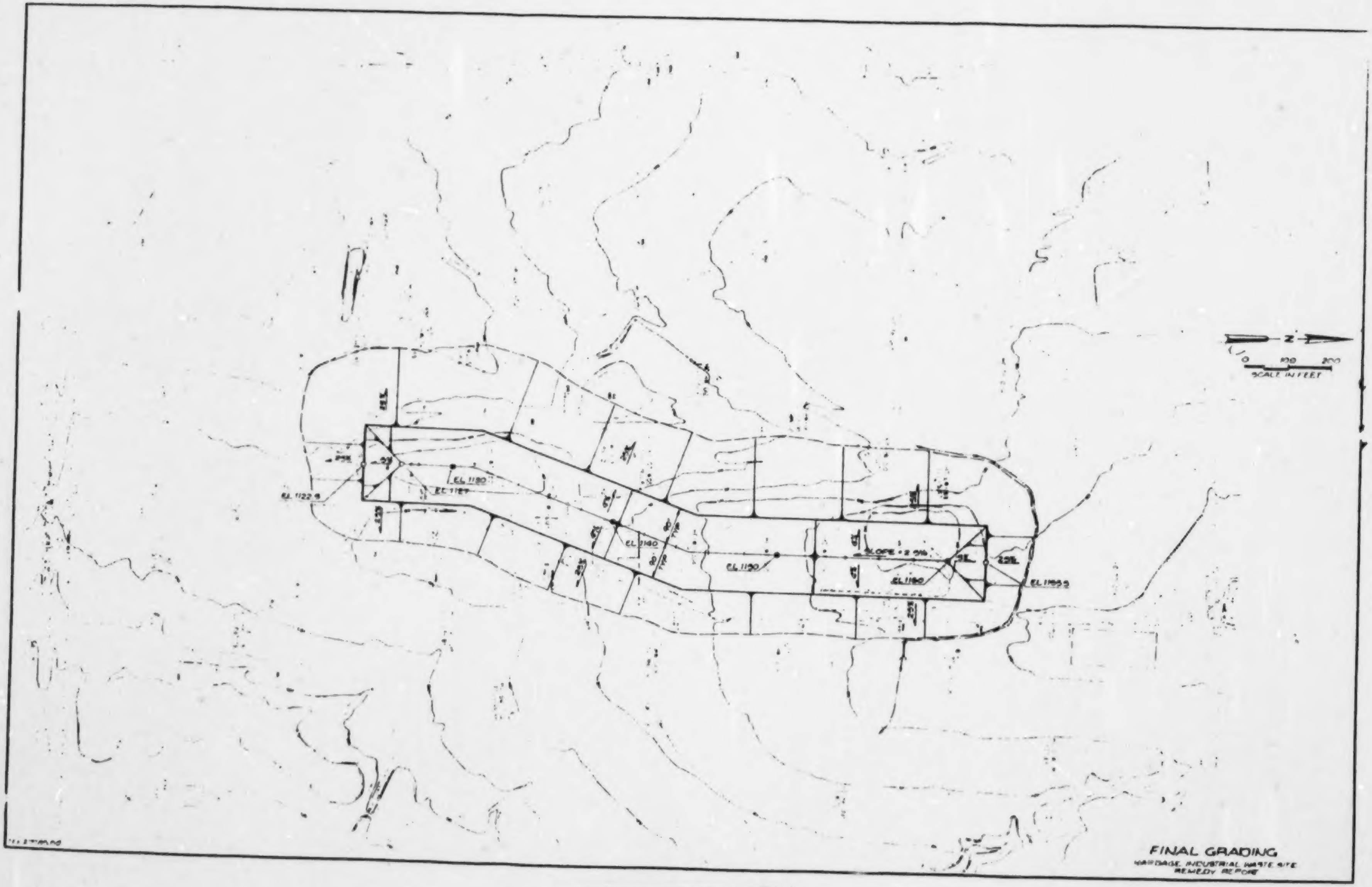
In addition to the new components considered for Source Control, remedial alternatives for contaminated groundwater were developed and described in detail as part of the Management of Migration Operable Unit RI/FS reports. All alternatives were developed assuming some form of concurrent Source Control remedial action. The alternatives were developed in light of the overall goal of restoring groundwater to its beneficial use within a reasonable timeframe.

Consideration of the hydrology and contamination of the bedrock aquifer at the site has led to the conclusion that restoration of bedrock groundwater underneath the source areas is technically impractical over a reasonable time period (a few decades). This conclusion is supported by the fact the some D-NAPL has escaped from the source areas and will continue to serve as as source for dissolved contaminants in groundwater. Also, some contaminants have diffused into dead-end cracks and fine-grained pores in the rock matrix; those materials will take a relatively long time to diffuse out of the pores and cracks during an active or passive restoration program. In view of these facts, the most effective way to address groundwater contamination onsite is through various containment efforts designed to control the spread of groundwater plumes and protect downgradient areas from future plume migration. Such efforts will be significantly aided by source control actions that in a timely manner permanently reduce the potent source liquids which continue to load the groundwater system with contaminants. Consequently, component alternatives wer screened and refined based on their effectiveness in meeting the following c jectives:

- intercept and captu groundwater that is migrating towards the alluvial aquifer an the east farm ponds, thereby protecting offsite areas from ture contaminant impacts, and commencing the process of natu l restoration in the alluvial system;

FIGURE 4-4

FINAL SOURCE AREA CAP


N
0 100 200
SCALE IN FEET
EL 1122.9
EL 1180
EL 1127
EL 1140
EL 1150
SLOPE = 2.0%
EL 1180
EL 1155.5
FINAL GRADING
HARDAGE INDUSTRIAL WASTE SITE
REMEDY REPORT

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- o monitor and control contaminated groundwater discharge to North Criner Creek to assure that Oklahoma Water Quality Standards for North Criner Creek and Criner Creek are met; and
- o prevent domestic and agricultural use of contaminated groundwater through continued supply of alternate water to affected residents.

In view of these objectives, ERM-Southwest, on behalf of the HSC (and pursuant to a partial Consent Decree with EPA) developed and evaluated 21 remedial action alternatives by combining 6 remedy elements (see Table 6-1). Details of this analysis is presented in the Management of Migration FS. All of the initial alternatives developed included groundwater and surface water monitoring, as well as actions to minimize runoff from the source areas. All alternatives relied on institutional controls (such as deed restrictions) to prevent the use of potentially contaminated groundwater as a drinking water supply. The alternatives also included continued operation of alternate water supplies to nearby residents.

Screening of these alternatives was conducted in the FS based on effectiveness in containing and capturing contamination, and cost. Six groundwater alternatives were retained after this screening for detailed analysis, and were summarized below:

Alternative	Description
A	No Action
B	Primary Controls - institutional controls on groundwater use, maintenance of alternate water supplies, and surface water controls to limit the discharge of contaminated groundwater to surface water.
C	Alternative B and Alluvial Recovery - groundwater recovery from the North Criner Creek alluvium using a well network or interceptor trench system (see Figure 6-5)
E	Alternative B and Alluvial, South Pond and Southeast Area Recovery - groundwater recovery from the North Criner Creek alluvium, from bedrock southwest of the Main Pit, Barrel Mound and Sludge Mound, and from bedrock east and southeast of these three source areas (see Figure 6-6) using a well network or interceptor trench system
K	Alternative B and South Pond Area Recovery - groundwater recovery from bedrock southwest of the three main source areas using a well network or trench system, with the the option of a local cut-off wall along the site fence boundary in place of a number of recovery wells
N	Alternative B and Main Source Area Recovery - groundwater recovery associated with source control measures using a well network.

TABLE 6-1

Revision #0
May 30, 1989

Summary of Alternative Elements

Second Operable Unit Feasibility Study
Royal Hardage Site
Criner, Oklahoma

Remedy Elements	Monitoring	Primary Controls	Alluvial Recovery	In Situ Bio-remediation	South Pond Area Recovery	Southeast Recovery	Recovery Trench
A: "NO Action"	x						
B: Primary Controls	x	x					
C: Primary Controls and Alluvial Ground Water Recovery	x	x	x				
D: Primary Controls, Alluvial and South Pond Area Recovery	x	x	x		x		
E: Primary Controls, Alluvial South Pond Area and Southeast Recovery	x	x	x		x	x	
F: Primary Controls, Alluvial and Southeast Recovery	x	x	x			x	
G: Primary Controls and In Situ Bioremediation	x	x		x			
H: Primary Controls, In Situ Bioremediation and South Pond Area Recovery	x	x		x	x		
I: Primary Controls, In Situ Bioremediation, South Pond Area and Southeast Recovery	x	x		x	x	x	
J: Primary Controls, In Situ Bioremediation, and Southeast Recovery	x	x		x		x	
K: Primary Controls, and South Pond Area Recovery	x	x			x		

TABLE 6-1 (continued)

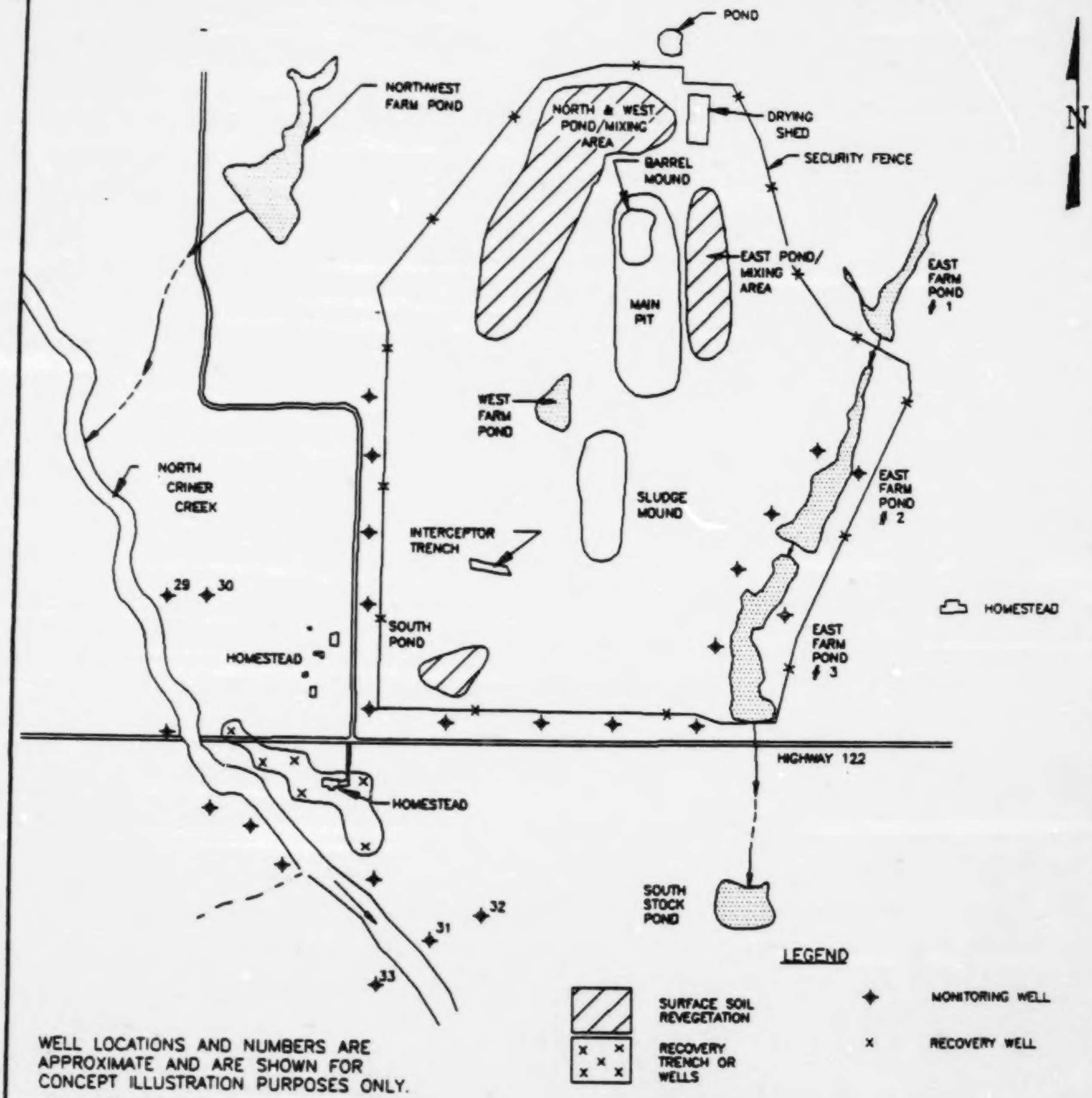
TABLE 4-1 (Continued)

Summary of Alternative Elements

Second Operable Unit Feasibility Study
Royal Hardage Site
Criner, Oklahoma

Remedy Elements	Monitoring	Primary Controls	Alluvial Recovery	In Situ Bio-remediation	South Pond Area Recovery	Southeast Recovery	Recovery Trench
L: Primary Controls South Pond Area and Southeast Recovery	x	x			x	x	
M: Primary Controls and Southeast Recovery	x	x				x	
N: Primary Controls and Main Source Area Recovery	x	x					
O: Primary Controls, Alluvial Recovery and Main Source Area Recovery	x	x					x
P: Primary Controls, Alluvial and South Pond Area Recovery and Main Source Area Recovery	x	x	x		x		x
Q: Primary Controls, In Situ Bioremediation, and Main Source Area Recovery	x	x		x			x
R: Primary Controls, In Situ Bioremediation, South Pond Area Recovery and Main Source Area Recovery	x	x		x	x		x
S: Primary Controls, South Pond Area Recovery and Main Source Area Recovery	x	x			x		x
T: Primary Controls, Main Source Area Recovery, Southeast and South Pond Recovery	x	x			x	x	x
U: Primary Controls, Alluvial, South Pond, Southeast Recovery and Main Source Area Recovery	x	x	x		x	x	x

NOTES:
'x' Indicates element is included in potential remediation alternative for screening purposes


POND
NORTHWEST FARM POND
NORTH & WEST POND/MIXING AREA
DRYING SHED
SECURITY FENCE
BARREL MOUND
N
EAST POND/ MIXING AREA
MAIN PIT
EAST FARM POND # 1
WEST FARM POND
SLUDGE MOUND
EAST FARM POND # 2
NORTH CRINER CREEK
INTERCEPTOR TRENCH
29
30
SOUTH POND
HOMESTEAD
EAST FARM POND # 3
HOMESTEAD
HIGHWAY 122
HOMESTEAD
SOUTH STOCK POND
32
31
33
LEGEND
SURFACE SOIL REVEGETATION
MONITORING WELL
RECOVERY TRENCH OR WELLS
RECOVERY WELL

WELL LOCATIONS AND NUMBERS ARE APPROXIMATE AND ARE SHOWN FOR CONCEPT ILLUSTRATION PURPOSES ONLY.

SOIL REVEGETATION AREAS ARE NOT EXACT AND ARE SHOWN FOR CONCEPT ILLUSTRATION PURPOSES ONLY.

ERM-Southwest, inc.

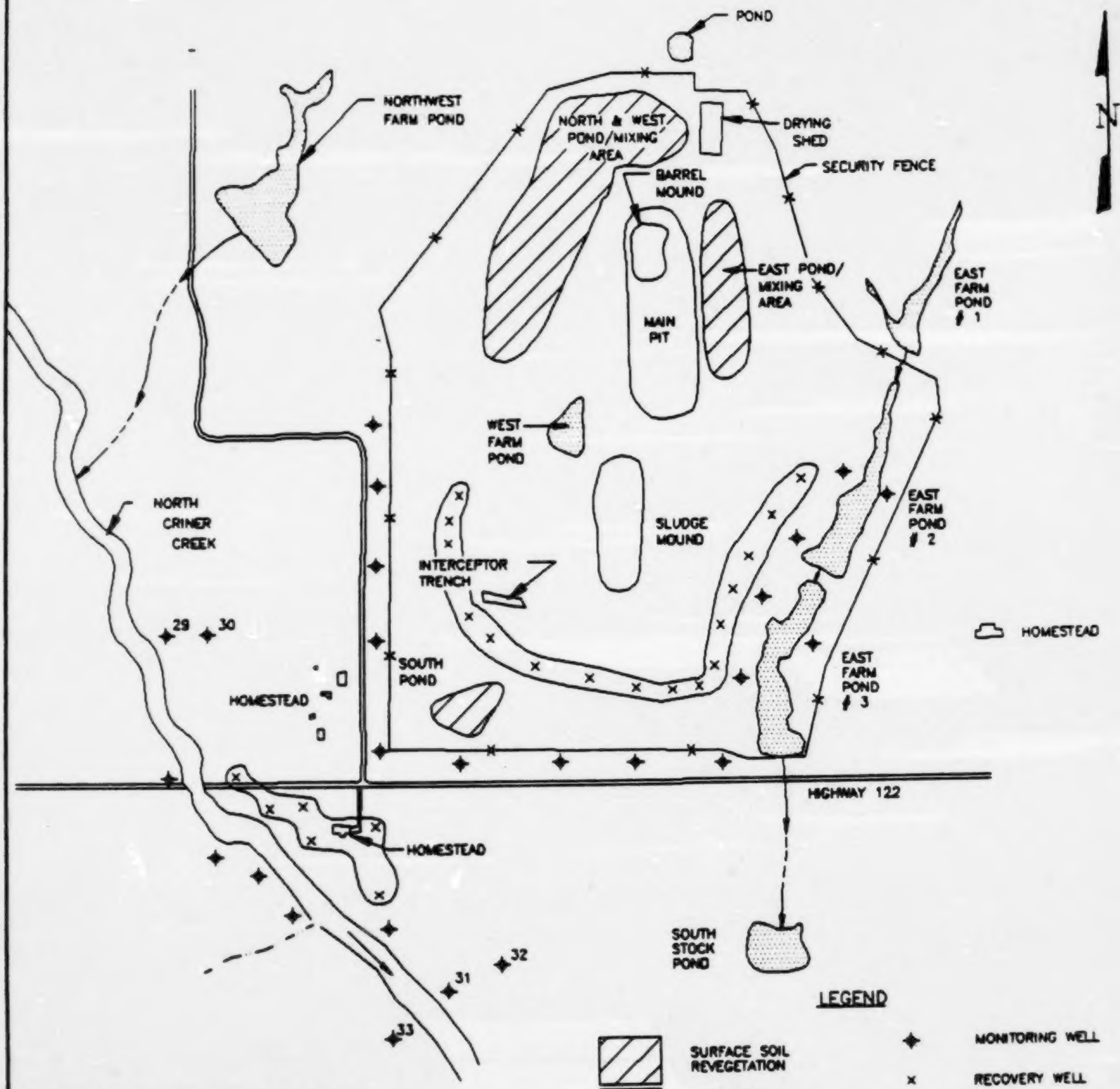
NEW ORLEANS, LOUISIANA HOUSTON, TEXAS

DATE 05/24/89

W.O.N. 7663A001E89

FIGUF 6-5

ALTERNATIVE C SI E SCHEMATIC
SECOND OPERABLE UNI FEASIBILITY STUDY
ROYAL HARD E SITE
CRINER, OK HOMA


POND
NORTHWEST FARM POND
NORTH & WEST POND/MIXING AREA
DRYING SHED
SECURITY FENCE
BARREL MOUND
EAST POND/ MIXING AREA
EAST FARM POND # 1
MAIN PIT
WEST FARM POND
SLUDGE MOUND
EAST FARM POND # 2
NORTH CRINER CREEK
INTERCEPTOR TRENCH
29
30
SOUTH POND
HOMESTEAD
EAST FARM POND # 3
HOMESTEAD
HIGHWAY 122
HOMESTEAD
SOUTH STOCK POND
32
31
33
N
LEGEND
SURFACE SOIL REVEGETATION
RECOVERY TRENCH OR WELLS
MONITORING WELL
RECOVERY WELL

WELL LOCATIONS AND NUMBERS ARE APPROXIMATE AND ARE SHOWN FOR CONCEPT ILLUSTRATION PURPOSES ONLY.

SOIL REVEGETATION AREAS ARE NOT EXACT AND ARE SHOWN FOR CONCEPT ILLUSTRATION PURPOSES ONLY.

ERM-Southwest, inc.
NEW ORLEANS, LOUISIANA HOUSTON, TEXAS

DATE 05/24/89
W.O.NO. 7663A001E89

FIGURE 6-6

ALTERNATIVE E SITE SCHE ATIC
SECOND OPERABLE UNIT FEASIE ITY STUDY
ROYAL HARDAGE SITE
CRINER, OKLAHOMA

Alternative E (illustrated in Figure 6-6) involves the recovery of contaminated groundwater in the southwest alluvial area of North Criner Creek and onsite groundwater recovery west, south, and east of the main source areas. Alternative E has been modified and includes two groundwater components. The onsite interceptor system is known as the V-Shaped Trench. The southwest interceptor system is known as the Southwest Interceptor Trench. Both the V-shaped and Southwest interceptor trenches would be capable, in combination with Source Control components of the comprehensive remedy, of modifying groundwater gradients at the site so as to contain and capture groundwater and D-NAPL migrating from the source areas and off the site.

A third trench, known as the U-Shaped Trench, was considered by EPA during the development of groundwater alternatives in order to prevent uncontaminated groundwater in the vicinity of the Main Pit/Barrel Mound from coming into contact with the source waste materials during remediation, as well as to support source liquids removal operations by intercepting lateral seepage that may ensue from the source areas.

These three recovery systems could be installed at the site to capture contaminated groundwater migrating towards the alluvium and the east farm ponds, provided Source Control measures are also instituted. Collected groundwater from any or all of these systems would be treated onsite to discharge standards before discharge to North Criner Creek. These collection systems are illustrated in Figure 6-7 and each is further described below:

6.2.1 U-shaped Trench

The first trench, known as the U-shaped trench, would intercept shallow seepage issuing laterally from the Barrel Mound and the Main Pit and to collect contaminated groundwater from Stratum I in the vicinity of the Barrel Mound and Main Pit.

6.2.2 V-shaped Trench

The V-shaped trench would intercept and collect contaminated groundwater from all bedrock zones existing above Stratum IV. The trench will be located so that groundwater contaminants already migrating eastward towards the east farm ponds will be captured by the trench, negating the need for additional gorundwater recovery measures east and southeast of the trench.

6.2.3 Southwest Interceptor Trench

The Southwest Interceptor Trench is to intercept and collect contaminated bedrock system groundwater prior to its natural discharge to the offsite alluvial aquifer along North Criner Creek. The trench will extend to Stratum IV and will collect contaminated groundwater from all bedrock zones above Stratum IV. A system of extraction wells could be used as an alternative to the Southwest Interceptor Trench provided they are equally effective at intercepting and collecting contaminated groundwater.

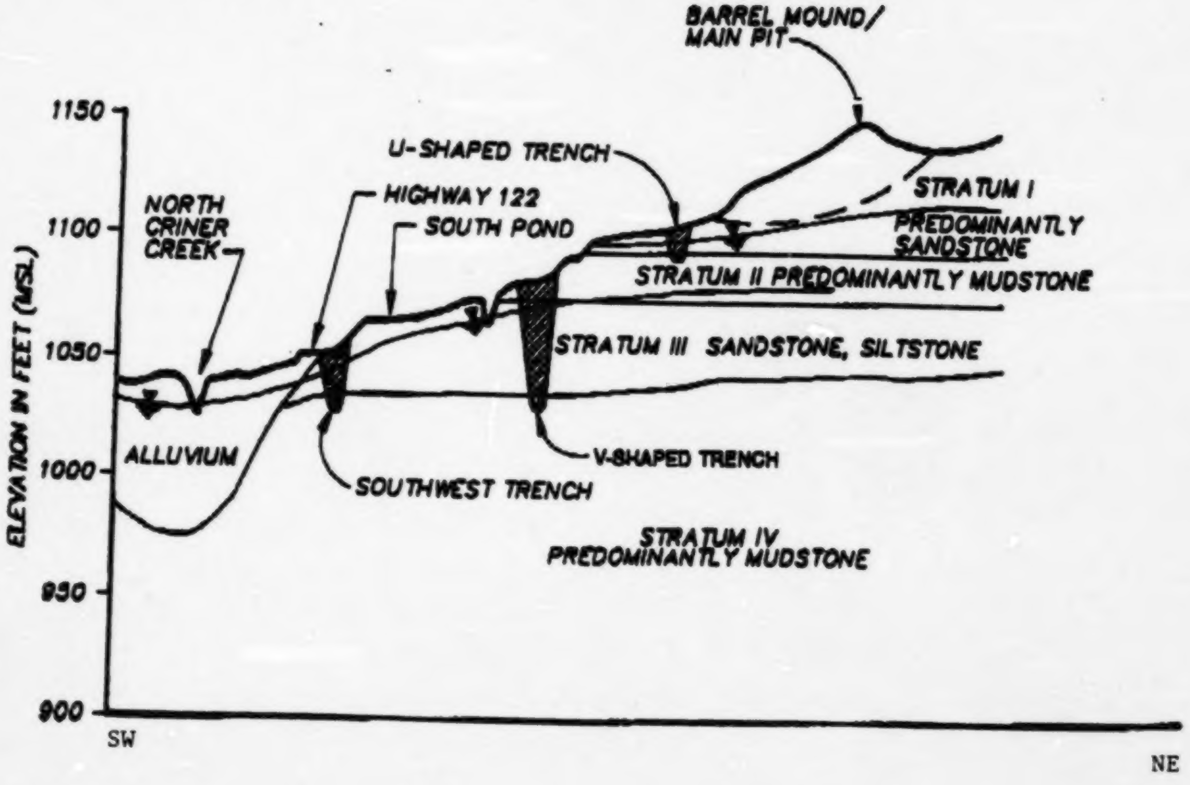

BARREL MOUND/ MAIN PIT
U-SHAPED TRENCH
HIGHWAY 122
SOUTH POND
NORTH CRINER CREEK
STRATUM I
PREDOMINANTLY SANDSTONE
STRATUM II PREDOMINANTLY MUDSTONE
STRATUM III SANDSTONE, SILTSTONE
ALLUVIUM
V-SHAPED TRENCH
SOUTHWEST TRENCH
STRATUM IV PREDOMINANTLY MUDSTONE
ELEVATION IN FEET (MSL)
1150
1100
1050
1000
950
900
SW
NE

FIGURE 7

SITE CROSS SECTION
SHOWING TRENCHES

6.2.4 Ground Water Treatment System

An onsite treatment plant would be provided to treat collected groundwater and surface water. The plant would be sized to handle flows from the groundwater collection trenches and the surface water collection system. The plant incorporates appropriate treatment processes to handle both organic and inorganic contaminants as necessary.

Following treatment, the plant would discharge to North Criner Creek. The plant would be designed to meet the applicable discharge requirements set by the Oklahoma Water Resources Board and the Oklahoma State Department of Health.

6.2.5 Alluvial Ground Water Restoration

Contaminants already present in the alluvial aquifer would be allowed to dissipate by natural dilution, biodegradation, and flushing. Future contaminant inputs to the aquifer will be abated by the trenches and the Source Control elements presented above to allow restoration to Maximum Contaminant Levels in the North Criner Creek alluvium. If alluvial monitoring reveals that estimated natural restoration time and plume dilution rates are not being met, then active restoration would be implemented. An increase in contaminant concentrations in the alluvium after trench installation and pumping, or a decline in the mass of contaminants of less than 40 percent in 10 years, would trigger active restoration in the alluvium.

6.3 Monitoring and Support Components

6.3.1 Remedial Support Facilities

Several components are needed to support the implementation of the remedy. These site control facilities consist of a command post, medical services station, close support analytical laboratory, sanitary facility, equipment maintenance shop, decontamination facilities for both equipment and personnel, and a supply center, gate guard, and communication center.

6.3.2 Institutional Controls

Institutional controls, including fencing, deed restrictions, and maintenance of the availability of an alternate water supply system would be implemented to restrict access to the site and contaminated groundwater.

6.3.3 Surface Water Controls

During implementation of the remedy, surface water drainage from the sourc areas would be collected as needed. Berms would be constructed to divert uncontaminated runoff water away from the working area to minimize the generation of contaminated water. A retention pond would be used to collect and store surface water prior to treatment. A Treated Water Retention Por would also be used to store treated groundwater prior to discharge to the surface drainage system for North Criner Creek.

Once the temporary cover is in place and the remedy has been implemented, surface water control and treatment would not be necessary. The diversions would be maintained over the life of the remedy as a means to control erosion of the cover.

6.3.4 Remedial Monitoring

A monitoring program would be instituted as part of the remedy to verify that the migration of contaminants has been halted. Streamwater in North Criner Creek would be monitored periodically for an indefinite future time to provide assurance that surface water discharge limits are not being exceeded downstream.

A line of monitoring wells at the downstream end of the alluvial contamination plume would be used to provide assurance that the plume is not expanding downgradient in the alluvial aquifer above acceptable levels.

The quantity and quality of liquids collected from the trenches would also be monitored. The effectiveness of the trenches in maintaining the desired hydraulic gradients and capture zones will be monitored by a series of piezometers positioned along lines perpendicular to the orientation of the trenches.

Bedrock groundwater monitoring wells (both new and existing) would be used to further verify the effectiveness of the trenches in controlling the spread of contaminated ground water.

The cap will also be monitored periodically to assure that differential settlement or erosion processes are not compromising the integrity of the caps.

Monitoring would be used to verify that the quality of downstream water resources is not being jeopardized during the natural restoration process.

Air quality would be monitored both onsite and at the site fenceline to assure that both onsite action levels and Maximum Ambient Air Concentrations are being met during remedy implementation.

6.4 Comprehensive Alternatives

From all of the components described in Sections 6.1, 6.2 and 6.3, three comprehensive remedial alternatives were assembled for consideration. These three alternatives, the Revised EPA Remedy, the Partially Revised EPA Remedy, and the HSC Remedy are described below and in Table 6-2.

6.4.1 Common Elements

Certain of the components from Section 6.1 are included in all three of the comprehensive alternatives. These are Institutional Controls (6.3.2), Surface Water Controls (6.3.3), Remedial Monitoring (6.3.4), and Remedial Support Facilities (6.3.1)

6.4.2 Revised EPA Remedy

The Revised EPA Remedy is a new source control remedy combined with groundwater collection and treatment. This remedy would remove a substantial portion of the liquid wastes, including many highly toxic and mobile volatile organic compounds, from source areas, thereby reducing the volume, toxicity and mobility of hazardous substances at the site. It calls for:

- Liquid Extraction Wells (6.1.5)
- In-Place Drum Lancing (6.1.6)
- Excavation of Wastes in Adjacent Areas (6.1.8)
- Soil Vapor Extraction and Treatment (6.1.9)
- Source Area Capping (6.10)
- U-shaped Trench (6.2.1)
- V-shaped Trench (6.2.2)
- Southwest Interceptor Trench (6.2.3)
- Groundwater Treatment (6.2.4)
- Alluvial Groundwater Restoration (6.2.5)

6.4.3 Partially Revised EPA Remedy

This remedy is essentially the same as the Revised EPA Remedy except that the buried drum concentrations in the Main Pit and Barrel Mound would be excavated (6.1.7) rather than lanced, and the U-shaped trench would not be needed. The use of excavation assures that all drummed liquids are removed and eliminates the short-term introduction of additional free liquids to the vadose zone resulting form lancing.

6.3.4 The HSC Remedy

This remedy is described in the Remedy Status Report which the HSC filed with the Federal District court in Oklahoma City on June 30, 1989 and described in greater detail in the HSC's Preliminary Design Report dated October 12, 1989, and also filed with the Court. It includes the following elements:

- Liquid Extraction Wells (6.1.5)
- V-shaped Trench (6.2.2)
- Southwest Interceptor Trench (6.2.3)
- Excavation of Wastes in Adjacent Areas (6.1.8)
- Groundwater Treatment (6.2.4)
- Alluvial Ground Water Restoration (6.2.5)

The HSC Remedy also includes capping of the three main source areas, but with a less effective cap than that proposed in the EPA remedies. The HSC cap does not meet RCRA requirements.

TABLE 6-2

HARDAGE SITE
COMPARISON OF ALTERNATIVES

	HSC REMEDY	REVISED EPA REMEDY	PARTIALLY REVISED EPA REMEDY
SOURCE CONTROL			
Excavation of Drums			✖
Liquid Extraction Wells	✖	✖	✖
Drum Lancing		✖	
U-Shaped Trench		✖	
Soil Vapor Extraction		✖	✖
Consolidation & Capping	✖	✖	✖
GROUNDWATER			
V-Shaped Trench	✖	✖	✖
Alluvial Recovery	✖	✖	✖
Common Groundwater Elements	✖	✖	✖

The HSC remedy does not contain the following Source Control components integral to both of the EPA remedies:

- Drum Excavation (6.1.7)
- Soil Vapor Extraction and Treatment (6.1.9)
- In-Place Drum Lancing (6.1.6) & U-shaped Trench (6.2.1) (in Revised Remedy)

A comparative analysis of each of these remedies is the subject of Section 7.

7.0 Comparative Anaysis

The remedial alternatives described in Section 6 have been assessed in light of criteria defined in CERCLA Section 121. This Section of CERCLA specifies that remedial actions must:

- Be protective of human health and the environment;
- Attain applicable or relevant and appropriate requirements (ARARs);
- Be cost-effective;
- Utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable;
- Satisfy the preference for treatment that reduces volume, toxicity, or mobility as a principal element or provide an explanation in the ROD as to why it does not.

In addition, CERCLA places an emphasis on evaluating long-term effectiveness and related considerations for each of the alternative remedial actions (§121(b)(1)(A)). These statutory considerations include:

A) the long-term uncertainties associated with land disposal;

B) the goals, objectives, and requirements of the Solid Waste Disposal Act (i.e., RCRA)

C) the persistence, toxicity, and mobility of hazardous substances and their constituents, and their propensity to bioaccumulate;

D) short- and long-term potential for adverse health effects from human exposure;

E) long-term maintenance costs;

F) the potential for future remedial action costs if the alternative remedial action in question were to fail; and

G) the potential threat to human health and the environment associated with excavation, transportation, and redisposal or containment.

Nine evaluation criteria have been developed to address the CERCLA requirements and considerations listed above, and to address the additional technical and policy considerations that have proven to be important for selecting among remedial alternatives. These nine criteria are discussed in a memorandum entitled "Interim Guidance on Superfund Selection of Remedy" from J. Winston Porter, Assistant Administrator dated December 24, 1986. The nine criteria are organized into three groups:

Threshold Criteria:

1. Overall protection of human health and the environment;

2. Compliance with applicable or relevant and appropriate requirements (ARARs);

Primary Balancing Criteria:

3. Long-term effectiveness and permanence;
4. Reduction of volume, toxicity and mobility through treatment;
5. Short-term effectiveness;
6. Implementability;
7. Cost

Modifying Criteria:

8. State acceptance;
9. Community acceptance.

If an alternative satisfies the threshold criteria, it is eligible for further analysis under the Primary Balancing criteria. The comparison of alternatives is given below as well as in Table 7-1. This comparative analysis provides the basis for EPA preference for the EPA excavation remedy.

7.1 Overall Protection of Human Health and the Environment:

The EPA excavation remedy provides the most overall protection of human and the environment. Both the EPA remedies provide short-term protection through the provision of alternate water supply the maintenance of site security, and land use controls to prevent exposure to contaminated groundwater. Although the EPA excavation remedy involves certain additional short-term risks in implementation, these risks can be significantly reduced or eliminated, primarily through controls on the emission of vapors and dust during excavation.

The EPA remedies provide long-term protection through the removal of a substantial volume the most highly toxic and mobile contaminants present in the source areas. The EPA excavation remedy is more effective in the removal of these contaminants than the EPA lancing remedy. Further long-term protection is provided by continued monitoring to assure that the remedy components continue to function as expected.

The HSC remedy provides the least overall protection of human health and the environment, particularly over the long-term. It would leave a large volume of untreated, toxic and mobile compounds, both in buried drums and in source area soils. These contaminants would pose a continuing threat threat to human health and the environment. The HSC remedy does not address the liquids from the source areas until they have migrated to the interceptor trenches. This process will take a long period of time, resulting in considerable uncertainty. The HSC remedy also relies on institutional controls to limit exposure to contaminated groundwater and surface water. The long-term maintenance of institutional controls

Table 7-1
COMPARISON SUMMARY ACCORDING TO STATUTORY CRITERIA

1. Overall Protection of Human Health and the Environment

HSC's Remedy	EPA's Remedy With Lancing	EPA's Remedy With Excavation
• Leaves drummed and adsorbed wastes/contaminants in the Sludge Mound and Main Pit/Barrel Mound resulting in long-term presence of contaminant sources onsite. More specifically, drums will corrode over time releasing their contents, and vadose/adsorbed contaminants would remain as a source of contamination. • Downward and horizontal migration of contaminants from sources left in place poses long-term risks (100's of years) which will need to be monitored. • Requires increased reliance on institutional controls. • Releases to air will also occur to a greater extent over the long term.	• Reduces the magnitude of long-term risks to human health and the environment. • Removes a significant mass of contaminants from the environment (drums, soils in Main Pit/Barrel Mound and Sludge Mound) through the use of soil vapor extraction (SVE) enhanced by lancing, and liquid extraction wells. • Meets statutory preference for utilizing treatment technology which permanently reduces the source term. Minimizes the volume/mass of contaminants subject to long-term storage/monitoring. • Reduces the potential for contaminants being released from sources, migrating away from sources, and escaping from down-gradient collection areas and offsite.	• Reduces the magnitude of long-term risks to human health and the environment. • Removes a significant mass of contaminants from the environment (drums, soils in Main Pit/Barrel Mound and Sludge Mound) through the use of SVE combined with removal of liquids by drum excavation and extraction wells. • Meets statutory preference for utilizing treatment technology that permanently reduces the source term. Minimizes the volume/mass of contaminants subject to long-term storage/monitoring. • Reduces the potential for contaminants being released from sources, migrating away from sources, and escaping from down-gradient collection areas and offsite.

Table 7-1
(Continued)

2. Compliance With ARARs

HSC's Remedy	EPA's Remedy With Lancing	EPA's Remedy With Excavation
• Will need to meet surface water discharge standards.	• Will need to meet surface water discharge standards.	• Will need to meet surface water discharge standards.
• Would not meet requirements of RCRA for unit closure as a hazardous waste management unit (eg., would allow migration between source areas and V-Shaped Trench).	• Can be designed to work with best available control technology (BACT) for air treatment (technology ARAR).	• Can be designed to work with BACT for air treatment (technology ARAR)
	• These alternatives involve SVE and the collection of vapors and treatment. Treatment will meet ARARs contained in the Oklahoma 3.8 regulations that allow for maximum ambient air concentration (MAAC) exceedances as long as monitoring and risk assessments assure safety.	• These alternatives involve SVE and the collection of vapors and treatment. Treatment will meet ARARs contained in the Oklahoma 3.8 regulations that allow for MAAC exceedances as long as monitoring and risk assessments assure safety.

Table 7-1
(Continued)

3. Long-Term Effectiveness

HSC's Remedy	EPA's Remedy With Lancing	EPA's Remedy With Excavation
• The remaining sources of risk and the magnitude of the residual risk will be greater because the HSC's remedy does not remove the mass of contaminants that the EPA's remedy does. • It is unlikely that the V-Shaped Trench will meet its intended objectives of intercepting and removing DNAPLS from the Main Pit and Barrel Mound. • Would require very long-term (indefinite) operation of the V-Shaped Trench and the liquid extraction wells to remove liquids from the Main Pit/Barrel Mound.	• Provides for greater long-term effectiveness by removing a significant mass of contaminants and therefore decreases the magnitude of the residual risk. • The degree of long-term management necessary will be minimized because contaminants are removed and treated. • SVE is a treatment technology that permanently removes contaminants from the Main Pit/Barrel Mound and Sludge Mound, resulting in a reduced waste mass and reduced source of contaminants to groundwater and air.	• Provides for greater long-term effectiveness by removing a significant mass of contaminants and therefore decreases the magnitude of the residual risk. • The degree of long-term management necessary will be minimized because contaminants are removed and treated. • SVE is a treatment technology that permanently removes contaminants from the Main Pit/Barrel Mound and Sludge Mound, resulting in a reduced waste mass and reduced source of contaminants to groundwater and air. • Excavation is a treatment technology that directly removes contaminants from the Main Pit/Barrel Mound and further reduces the waste mass available for contaminated migration.

Table 7-1
(Continued)

4. Reduction of toxicity, mobility, or volume through treatment

HSC's Remedy	EPA's Remedy With Lancing	EPA's Remedy With Excavation
• Does not treat sources at the site to the maximum extent possible and, therefore, does not reduce the same volume of contaminants that the EPA's remedy does. • The mobility of the contaminants that are not treated will increase with time as the drums corrode and release liquids. • Does not satisfy the statutory preference for treatment as a principal element of the remedy. • Allows mobility between the three source areas and the V-Shaped Trench, whereas EPA's remedy prevents this.	• Treatment-based remedy that addresses each of the sources and media at the site. • Removal and destruction of contaminants is irreversible. • Satisfies the statutory preference for treatment as a principal element of a remedy. • The volatiles removed via soil vapor extraction are among the most toxic at the site and, therefore, a significant reduction in toxicity is provided and hence residual risk to human health and the environment. • Lancing with liquids extraction removes toxic and hazardous wastes from the site.	• Treatment-based remedy that addresses each of the sources and media at the site. • Removal and destruction of contaminants is irreversible. • Satisfies the statutory preference for treatment as a principal element of a remedy. • The volatiles removed via soil vapor extraction are among the most toxic at the site and, therefore, a significant reduction in toxicity is provided and hence residual risk to human health and the environment. • Excavation further removes toxic hazardous wastes from the site.

Table 7-1
(Continued)

5. Short-Term Effectiveness

HSC's Remedy	EPA's Remedy With Lancing	EPA's Remedy With Excavation
• Vapors currently dispersing into the atmosphere at the site will be reduced by capping. • Impacts on community during remediations will be minimal • Vapors from liquid extraction and temporary onsite storage will be controlled. • Vapors from groundwater treatment will be controlled through BACT.	• Area residents will be protected from contaminant releases by treating SVE air stream with catalytic oxidation. • Impacts on community during implementation will be minimal. • Controlled or remote lancing will be used if worker risks during lancing are unacceptable. • Vapors will be produced from SVE and treated onsite to meet ARARs. In the event that MAACs, are exceeded, particularly during early periods of SVE operation, levels will be monitored continuously at the fence lines and stack, and releases minimized through pilot testing during design implementation. • Controlled lancing, but untested here.	• Area residents will be protected from contaminant releases by treating SVE air stream with catalytic oxidation. • Impacts on community during excavation will be evident but controllable. • Vapors will be produced from SVE and treated onsite to meet ARARs. In the event that MAACs are exceeded, particularly during early periods of SVE operation, levels will be monitored continuously at the fence lines and stack, and releases minimized through pilot testing during design implementation. • Proven technology, controlled risks.

Table 7-1
(Continued)

5. Short-Term Effectiveness (continued)

HSC's Remedy	EPA's Remedy With Lancing	EPA's Remedy With Excavation
	• Vapors from liquid extraction and temporary onsite storage will be controlled (treated). • Risk exists from the mixing of incompatible wastes	• Vapors from excavation and temporary onsite storage of liquid wastes will be controlled (treated).

Table 7-1
(Continued)

6. Implementability

HSC's Remedy	EPA's Remedy With Lancing	EPA's Remedy With Excavation
• Technologies and technology components are implementable.	• SVE systems have been constructed and successfully operated at sites with similar characteristics. • Lancing has been demonstrated in the field, except at a hazardous waste site. • Trenching, capping, liquids extraction, water treatment, and air treatment are proven technologies.	• SVE systems have been constructed and successfully operated at sites with similar characteristics. • Trenching, capping, liquids extraction, water treatment, and air treatment are proven technologies. • Excavation of drummed wastes has been successfully completed at other hazardous waste sites.

Table 7-1
(Continued)

7. Costs

HSC's Remedy	EPA's Remedy With Lancing	EPA's Remedy With Extraction
• Capital Cost = $26.88 - $40.32 million	• Capital Cost = $43.9 million	• Capital Cost = $48.6 million
• Annual O&M = $720,000 - $960,000	• Annual O&M = $1.4 million	• Annual O&M = $1.3 million
• 30-year Present Worth = $36.4 million - $54.6 million	• 30-year Present Worth = $58.9 million	• 30-year Present Worth = $62.9 million

Table 7-1

(Continued)

8. State Acceptance

HSC's Remedy	EPA's Remedy With Lancing	EPA's Remedy With Excavation
* Components are acceptable, but State would prefer more removal.	* State supports all ground water removal and treatment elements.	* State supports all ground water removal and treatment elements.
* State supports common remedy elements.	* State supports common remedy elements.	* State supports common remedy elements.
	* State has concerns regarding safety of drum lancing and risk to workers and the public.	* State has concerns regarding safety of excavation and risk to workers and the public.
	* State supports liquid extraction, excavation of adjacent areas, capping, and soil vapor extraction.	* State supports liquid extraction excavation of adjacent areas, capping, and soil vapor extraction.

Table 7-1
(Continued)

9. Community Acceptance

HSC's Remedy	EPA's Remedy With Lancing	EPA's Remedy With Excavation
* Community prefers more removal and destruction of contaminant sources.	* Community supports additional removal and destruction in the EPA remedy.	* Community supports additional removal and destruciton in the EPA remedy.

results in further uncertainty.

The EPA remedies take a more direct approach to protection of human health and the environment. The first element of this is the removal of contaminants from the source areas and destroying them. By removing and destroying the contamination at the source, any uncertainties as to their future threat are minimized.

The threat to human health and the environment is most acute from those wastes which migrate the easiest and by those which are known or suspected to cause cancer. The EPA remedies both protect human health and the environment through the rapid removal and destruction of those contaminants that are the most mobile and carcinogenic. Both minimize contaminant migration through the elimination of contaminants at the source not only through removal of liquids through extraction wells and either excavation or lancing of drums, but have the added protection of soil vapor extraction (SVE). The SVE system is predicted to remove 99% of the volatile, carcinogenic wastes from the source areas. When they are destroyed following their removal the threat from these contaminants will have been eliminated. In addition to controlling the contamination at the source, the EPA remedies also protect against those contaminants which remain through the groundwater recovery trenches and elimination of infiltration with a regulatorily compliant cap. Therefore, the EPA remedies have the multiple protection of extensive removal and destruction of the contaminant sources combined with a groundwater collection and treatment system to capture any residual contamination. The primary element of the HSC remedy, on the other hand, is groundwater capture and treatment alone.

In terms of two EPA proposals, the comparison is basically between the excavation of the buried drums or lancing them in association with the U-shaped trench. Both activities have elements of risk associated with implementation, but the risk associated with excavation of the drums is less than that of lancing as discussed in Sections 6.1.6 and 6.1.7. . Therefore the combined remedy retaining excavation of the drums is overall, more protective.

7.2 Compliance with ARARS:

Section 121 of CERCLA provides that, except under certain narrow exemptions, remedial actions shall comply with Federal and State laws that are legally applicable or relevant and appropriate to the contaminants and circumstances of the site. The process by which potential ARARs are identified, screened, and analyzed to determine if they actually are ARARs is described in "CERCLA Compliance with Other Laws Manual" (EPA 1988a). The alternatives described in Section 6.4 are broken down below into remedial elements to facilitate the analysis:

ARARs may be identified in three general classes:

1. chemical specific - for example, a drinking water "MCL" defines a maximum acceptable concentration for drinking water;
2. action specific - for example, a landfill built to accept hazardous wastes would have to meet RCRA 264, Subpart N regulations and associated requirements on design of the landfill;
3. location specific - for example, the hazardous waste landfill described above could not be built on a flood plain.

Key among those ARARs, shown in more detail in Appendix A, are the chemical specific drinking water requirements or Maximum Contaminant Levels (MCLs) established under the Safe Drinking Water Act, and the requirements under the Resource Conservation and Recovery Act (RCRA) which relate to the construction of hazardous waste facilities and their closure. Table 4-2 gives the chemical specific MCLs that would apply to those contaminants that have already migrated into the North Criner Creek alluvium. None of the alternatives would result in rapid restoration of the groundwater onsite to drinking water standards. However, the two EPA remedies would accomplish this goal more rapidly than the HSC through the elimination of contaminant sources. The HSC remedy would also fail to meet the RCRA requirements for its cap. The RCRA requirements for the construction of caps are very specific and the HSC cap does not meet them. The cap proposed under the EPA remedies would meet these requirements.

7.3 Long-term Effectiveness and Permenance

Both of the EPA remedies emphasize recovery and destruction of the contamination at the source. Through the removal of the liquids still contained in the drums, and of contaminants in the contaminated soils and sludges through soil vapor extraction, direct elimination of contaminants at their source is achieved. These contaminants are then destroyed through treatment. It is through this early removal of the contaminants at their source that the EPA alternatives are superior to the HSC alternative. Long-term effectiveness is dependent upon the performance of the alternative over time. This long-term effectiveness is best enhanced through the elimination of uncertainties associated with an alternative. The greatest uncertainty with these alternatives is the potential for long-term migration of contaminants out of the source areas. The uncertainty of the capture of migrating contaminants by the groundwater trenches will always remain and will grow as the time of operation needed for those trenches increases. The EPA remedies effectively address these uncertainties through the elimination of contaminants at the source. Once the contaminants are removed and destroyed the uncertainty is eliminated. Moreover, the uncertainty as to long-term effectiveness of the groundwater capture and treatment systems is also reduced by the elimination of contaminants at the source. If the magnitude of the sources of the migrating contaminants is reduced, then any future risk of their movement through or around the capture and treatment system is also reduced as is the time of operation of the trenches.

The HSC remedy would do considerably less than the EPA remedy to remove contaminants at the source and would allow their continued migration for an undetermined amount of time. By allowing contaminants to remain in place for a longer period, the HSC remedy is less effective over the long-term than either of the EPA remedies. This is shown through the compound uncertainties associated with the HSC alternative. The first of these is uncertain length of operation of the HSC alternative due to remaining contaminant sources. Added to this uncertainty are those of the ability to maintain the system over this length of time and the increased opportunity for contaminants to escape over this period.

7.4 Reduction of Volume, Toxicity or Mobility

CERCLA states, in section 121(a)(1), a clear preference for remedies which reduce the volume, toxicity, and mobility of waste. The EPA remedies would both reduce the mobility and volume of the contaminants through their removal and destruction at the source. The soil vapor extraction, moreover, would remove the most highly mobile volatile organic compounds from the soils of the source areas. The HSC remedy allows both greater mobility and volumes of waste since the HSC alternative would only recover the contaminants that enter the two HSC interceptor trenches. Waiting for the wastes to migrate to the trenches allows for a greater volume of contaminated material as the contamination spreads to greater amounts of groundwater and soils as it migrates. The mobility of the wastes is also greater in the HSC remedy than in the EPA remedies as it allows the wastes to migrate and become more dilute rather than taking the more efficient approach of capturing them and destroying them in concentrated form in the source areas.

The treatment of source areas with soil vapor extraction would remove a large portion of the carcinogenic compounds in those areas and destroy them thereby reducing the toxicity of the contaminants rapidly. Again, the HSC relies on all contaminants to enter their collection systems. As for volume of contaminants, the EPA remedies, by eliminating contamination at the source, would directly reduce contamination through the recovery and destruction of contaminants and would reduce the future volume of contaminated material by eliminating the migration of these (contaminants and their subsequent contamination of soil and groundwater as they spread). The HSC remedy would allow the migration of contaminants out of the source areas not only further contaminating the groundwater and soils between the source areas and the collection trenches, but increasing the potential for the escape of contamination both vertically and horizontally either under or around the control systems.

7.5 Short-term Effectiveness

The short-term effectiveness for the HSC remedy would be higher than that for either EPA remedy as, since nothing would be done about the contamination at the source, there would be none of the attendant risks of taking action. It should be noted, however, that the short-term risks of taking action can be addressed through use of appropriate safety and engineering methods.

Both EPA remedies pose certain short-term risks. If the drums in source areas are excavated, then the soils around the drums will be disturbed and exposed to air. This creates an opportunity for volatilization of contaminants. The risks associated with excavation and lancing of drums have been examined. The risks to onsite workers are related to the excavation and handling of the waste drums and the surrounding materials. Drum excavation has been successfully implemented at a number of hazardous waste sites (see Table 7-2) and the effects are known. Exposure of site workers to hazardous substances and situations during the implementation of either EPA remedy can be minimized or prevented with well-planned and implemented personnel training programs, the supply and utilization of the appropriate safety and personal protection equipment and the development and use of an effective site safety plan.

The risk to individuals offsite has also been examined. The primary risk to those offsite comes from release of volatile chemicals or contaminated dust from the site. This contamination could reach individuals through two primary pathways, inhalation of volatile chemicals or consumption of beef and milk from livestock maintained in the area. The total extra lifetime human cancer risk from ingestion of beef and milk is estimated to be seven in ten million. This also assumes, conservatively, that the ten million individuals exposed obtain 100% of their beef and milk from the effected area. More realistic estimates of exposure and ingestion would reduce the seven extra cancer risk in ten million exposures even further.

SELECTED HAZARDOUS WASTE SITE HISTORIES - DRUM REMOVALS

TABLE 7-2

SITE NAME/ LOCATION	SOURCE OF INFORMATION	NUMBER OF DRUMS REMOVED	DATE DRUMS REMOVED	RELEVANT COMMENTS
Demode Site Rose Township MI	Paul Gauthier OSC Michigan DNR (517) 373-8427	4,500	1979-80	No reported accidents to onsite workers. Drums contained PCB & other wastes.
Springfield Township MI	Paul Gauthier OSC Michigan DNR (517) 373-8427	1,500	1979-80	No reported accidents to onsite workers. Drums contained PCB & other wastes.
Gilson Rd./Sylvester/ Nashua Site N H	Chet Janowski RPM Region 1 (617) 573-9623	1,300	1980	No reported accidents to onsite workers. Drums removed from surface of site.
Piccolo Farm RI	EPA Record of Decision	30,000	1980	Drums contained PCB's and VOC's.
Goose Farm NJ	EPA Record of Decision	5,000	1980	Drums 10 to 40 years old.
Enterprise Ave Philadelphia PA	EPA Record of Decision, and Walt Graham, RPM EPA Region 3 (215) 597-2193	1,700	1982	No reported incidents. Age of drums estimated at 10 to 20 years. Mostly solvents, rosins & resins. Site removed from NPL.
Taylor Burrough Scranton PA	Pat Tan RPM EPA Region 3 (215) 597-3164	1,200	1983	No reported accidents to onsite workers. Drums were removed from site surface only. Half were empty.
Tower Chemical Lake City FL	EPA Record of Decision	72	1983	Drums 2 to 32 years old.

SELECTED HAZARDOUS WASTE SITE HISTORIES - DRUM REMOVALS

TABLE 7-2 (continued)

SITE NAME/ LOCATION	SOURCE OF INFORMATION	NUMBER OF DRUMS REMOVED	DATE DRUMS REMOVED	RELEVANT COMMENTS
Cleve Reber LA	EPA Record of Decision	1,100	1983	More drums on site to be removed.
Berlin Farro MI	Pete Ollila Michigan DNR (517)373-8174	20,000+	1984	No reported accidents to onsite workers. Drums excavated up to 22 ft. Says drums have been removed at over 300 sited in MI.
Byron/Johnson Salvage Byron, IL	Bill Bolen RPM EPA Region 5 (312) 353-6316	100's	1985	No accidents. Drums excavated and removed. Used bulldozer to remove them from surface & ravines.
Aberdeen Pesticide Dump Aberdeen SC	Ned Jessup OSC EPA Region 4 (404) 347-3931	687	1986-87	No accidents or injuries. Excavated to 10 ft.. Most drums empty when removed.
Denver-Arapahoe Chem Waste Mgmt Facility CO	EPA Record of Decision	30,000	1986-87	Drums 8 to 10 years old.
Bioecology Dallas TX	Steve Veale RPM EPA Region 6 (214) 655-6715	3,000 (est.)	1987-88	No accidents related to drum removal operations. Level B & C. Excavated 85,000 cu. yards soil & debris including buried drums (drums approx. 1 % of waste).
Lackawanna Refuse Site Lackawanna City PA	Walter Graham RPM EPA Region 3 (215) 597-2193	8,000	1988	No reported accidents to onsite workers. Drums removed from stripmine landfill. None intact. Excavated 30-35 ft. deep over 5 acre area.
Zieman Gramss Landfill Monroe County MI	Ross Powers OSC EPA Region 5 (313) 675-3178	2,200	1988	No reported accidents to onsite workers. Slow work. Level B. Excavated to 6 ft. with bulldozer & grappler.

SELECTED HAZARDOUS WASTE SITE HISTORIES - DRUM REMOVALS

TABLE 7-2 (continued)

SITE NAME/ LOCATION	SOURCE OF INFORMATION	NUMBER OF DRUMS REMOVED	DATE DRUMS REMOVED	RELEVANT COMMENTS
Syntex Landfill Lyons, CO	Gary Kaufman Env. Engineer Syntex (303) 938-6430 & Mark Davis CO Geol. Survey (303) 866-2611	15,000	1988	No reported accidents to onsite workers. USPCI excavated 28,000 tons of contaminated soil and 15,000 drums of contaminated wastes which were sent off-site for disposal and treatment. Drums 10 to 20 years old or older.
Great Lakes Container MI	Paul Gauthier OSC Michigan DNR (517) 373-8427	750+	on-going	No reported accidents to onsite workers. Shallow operation (1 to 2 ft.).
D'Imperio Drum Dump Atlantic City NJ	Romona Pezzella RPM Region 2 (212) 264-8216	130 (est.)	1986-87	No reported accidents to onsite workers. Excavated 3900 cu. yards of soil & drums.
Auburn Rd. Landfill N H	Don Burger OSC, Region 1 (617) 860-4360	to be provided		Major drum excavation close to residential area. Buried 8 to 10 ft..
Ottati Goss N H	Don Burger OSC, Region 1 (617) 860-4360	to be provided		Drums excavated under U.S. EPA Emergency Response Cleanup Services Contract (ERCS).
Davis Liquid RI	Don Burger OSC, Region 1 (617) 860-4360	to be provided		Drums excavated under ERCS.
Blosinski Landfill PA	Walter Graham RPM EPA Region 3 (215) 597-2193	50-60	1982	No reported accidents to onsite workers. Only surface drums & a tank truck were removed.

The total extra lifetime human cancer risk from inhalation of chemicals released during excavation of the Barrel Mound and part of the Main Pit is estimated to be one in ten million. The estimated risk from operating of the SVE system is six in ten billion.

The opportunity for volatilization can be reduced through using the smallest possible working face and thereby limiting the contaminated materials exposed to the air. Common sense precautions such as excavating during cooler weather will also reduce volatilization. The use of volatilization control techniques such as foam supressants can also be used.

Other short-term risks were also considered. The intermingling of the drummed liquids can be limited through the segregation of the drum contents as they are removed. The short-term risks associated with the drum lancing proposal include those associated with the physical puncturing of the drums and of the mixing of the liquids after they are released by the lancing. The risks of lancing can be reduced through the use of controlled lancing. The work would proceed gradually with the removal of liquids released as rapidly as feasible during the lancing. The lancing work could also be done by remote control to protect site workers. The risks of puncturing the drums could be reduced through the use of non-sparking materials on the lance points and through the use of carbon dioxide to eliminate the oxygen supply through the lance hole if needed. It is important to note that there is already extensive mixing of the source area liquids as evidenced by the amount of pooled liquids in the Barrel Mound. This would indicate that the risks from further mixing are less than might otherwise be anticipated.

Of these two alternatives, excavation poses less of a short-term risk. It allows greater control and observation of the hazardous materials that are disturbed.

7.6 Implementability

The majority of all three alternatives use established technologies and could be implemented. Only the lancing of drums has not been attempted at a hazardous waste site. The lancing technique has been demonstrated for the puncturing of buried drums and has been used for other industrial purposes. This one point leads to a slight preference for the EPA excavation alternative and the HSC proposal over lancing for this criteria.

7.7 Cost

Because it is a less extensive remedy, the HSC remedy is cheaper than either of the EPA remedies. It is important to remember that the HSC proposal is not an equally protective remedy when compared to the two EPA proposals. The relative estimated costs for the three alternatives are: HSC $46 million, EPA with excavation $63 million, and EPA with lancing $59 million. An additional consideration is costs associated with remedy failure.

With greater amounts of waste remaining in the source areas for a longer period under the HSC remedy, the potential exists for greater costs should additional remedial work be required.

7.8 State and Community Acceptance

State comment on the proposed plan for remedial action can be found in the transcript for the public meeting held on October 26, 1989 and in their letter of November 13, 1989. Basically the Oklahoma State Department of Health as representative of the State of Oklahoma supports elements of EPA's selected remedy including soil vapor extraction, but disagrees with with the excavation or lancing of the drums in the source areas, and with the use of catalytic oxidation as a thermal treatment.

Public comment expressed at the public meeting showed a preference for quicker action and for more permanent remediation. To quote one of the local residents who spoke at the public meeting,

> "... Personally, I think that the way that some of the basic ideas that you have got about addressing the cleanup of this is good. I particularly like the idea of removing the drums. When you start taking these materials out, when you remove them from the site completely, it's the only way that you are going to create any kind of confidence that you have really cleaned it up."

SECTION 8: THE SELECTED REMEDY

Based upon consideration of the requirements of CERCLA as specified in Section 7.0 of this document, the detailed analysis of the alternatives, and State and public comments, EPA has determined that the Partially Revised EPA Remedy involving the excavation of drums for liquids removal, is the most appropriate remedy for the Hardage/Criner site near Criner, Oklahoma. A schematic of the selected remedy is shown in Figure 8-1.

The first element of the selected remedy is the removal and destruction of contaminants in the source areas. Free liquids within the three major source areas, the Barrel Mound, Sludge Mound and Main Pit, would be removed through extraction wells. Organic liquids would be transported offsite for destruction and aqueous liquids treated onsite. Drum concentrations in the Barrel Mound and Main Pit would be excavated. Liquids in the drums would be removed and taken offsite for destruction. Solids would be restored to the three main source areas. Contamination from adjacent areas would be consolidated into the three main source areas. These source areas would be treated through soil vapor extraction (SVE) to remove contaminants. The resulting SVE effluent contaminants would be destroyed onsite using thermal treatment. It is this element of the recovery and destruction of the contamination at its source that is missing from the HSC remedy and which confers the greatest degree of superiority to the selected remedy over that recommended by the HSC. The reduction in the long-term uncertainties associated with leaving large portions of the source areas of contamination unremediated, as in the HSC alternative, is another area in which the superiority of the selected remedy over the HSC alternative is demonstrated.

The second element of the selected remedy would be control of residual contamination. The major source areas would be capped first temporarily during treatment and removal in the source areas, and then permanently with a regulatorily compliant cap following completion of the main treatment and removal phase. Groundwater would be collected through interceptor trenches and treated onsite. Surface water controls would be instituted to minimize contaminated runoff.

Finally, institutional controls would be implemented to prevent use of contaminated groundwater downgradient of the source areas. Alternate water supplies would be continued to replace supplies lost through contamination. The site boundaries would be expanded from the original site to the area indicated in Figure 4-6 to facilitate the implementation of the institutional controls.

The estimated cost for the selected remedy is $63 million. Table 8-1 gives a breakdown of this estimate and a detailed cost estimate can be found in Appendix G.

8.1 Remediation Goals

The purpose of this action is to protect human health and the environment through control of risks posed by the Hardage/Criner site and minimizing further migration of the site contaminants. Estimates of the risk of cancer from lifetime use of residential water contaminated at the level of the Old Corley well range as high as 0.0007 (seven per ten thousand) to 0.006 (six per thousand) far above the one per hundred thousand risk which is the upper

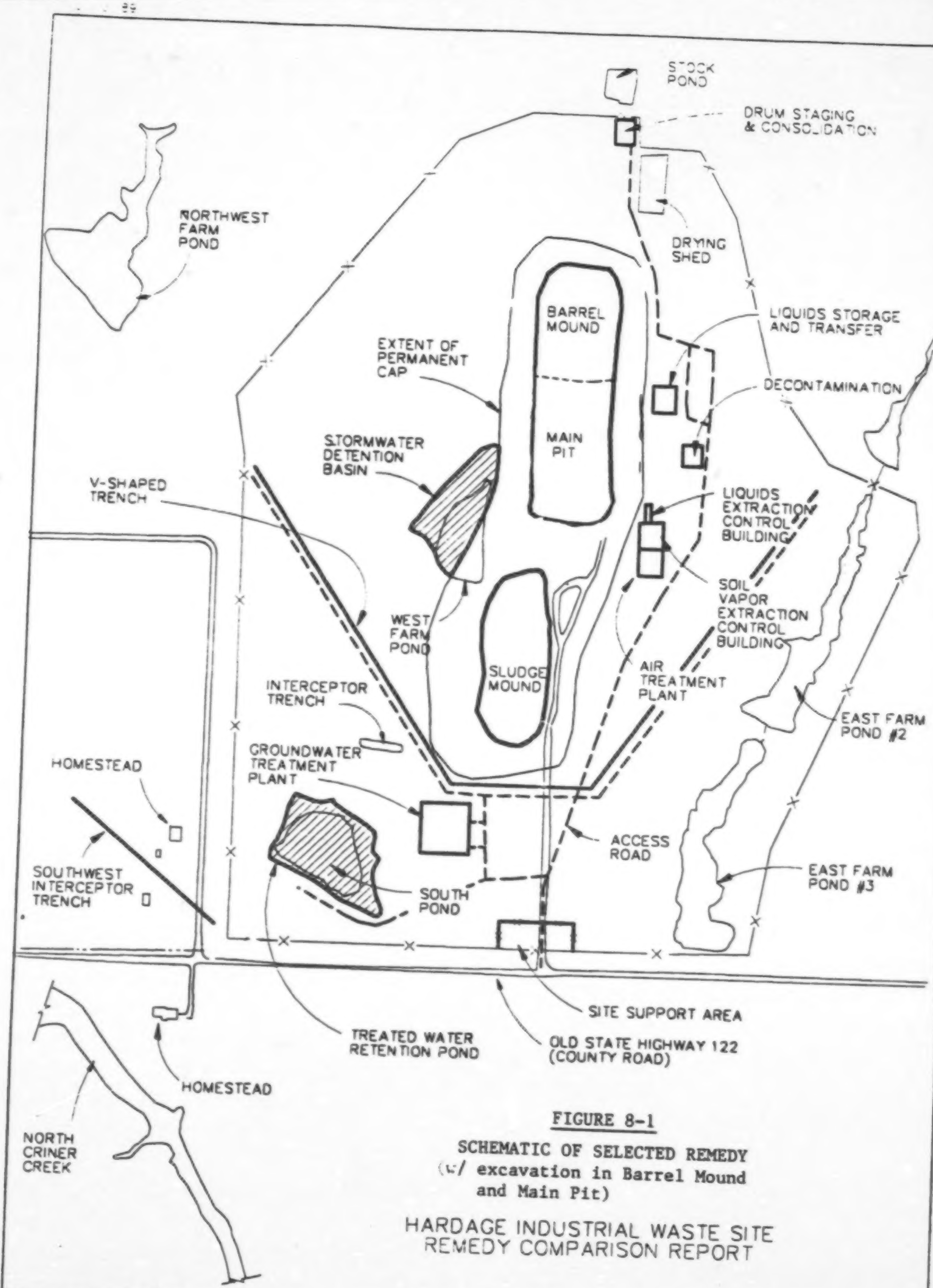

STOCK POND
DRUM STAGING & CONSOLIDATION
NORTHWEST FARM POND
DRYING SHED
BARREL MOUND
LIQUIDS STORAGE AND TRANSFER
EXTENT OF PERMANENT CAP
DECONTAMINATION
MAIN PIT
STORMWATER DETENTION BASIN
V-SHAPED TRENCH
LIQUIDS EXTRACTION CONTROL BUILDING
SOIL VAPOR EXTRACTION CONTROL BUILDING
WEST FARM POND
SLUDGE MOUND
AIR TREATMENT PLANT
INTERCEPTOR TRENCH
EAST FARM POND #2
GROUNDWATER TREATMENT PLANT
HOMESTEAD
ACCESS ROAD
EAST FARM POND #3
SOUTHWEST INTERCEPTOR TRENCH
SOUTH POND
SITE SUPPORT AREA
TREATED WATER RETENTION POND
OLD STATE HIGHWAY 122 (COUNTY ROAD)
HOMESTEAD
NORTH CRINER CREEK
89
\HOUST\TEX27785\17785.44.DWG

FIGURE 8-1

SCHEMATIC OF SELECTED REMEDY
(w/ excavation in Barrel Mound
and Main Pit)

HARDAGE INDUSTRIAL WASTE SITE
REMEDY COMPARISON REPORT

TABLE 8-1

COST SUMMARY FOR THE SELECTED REMEDY[1]

Liquids Removal and Control	$ 6,449,745
Drummed Waste Staging/Consolidation Area and Storage	2,813,516
Soil Vapor Extraction and Treatment	3,098,052
Removal of Adjacent Wastes	2,168,834
Source Area Capping	3,722,605
Ground Water Extraction and Treatment	5,971,286
Remedy Support Facilities	3,237,290
Surface Water Controls	196,000
Remedial Monitoring	41,250
Institutional controls	608,250
	$28,306,837
Bid and Scope Contingency	9,907,393
Implementation Costs	10,317,842
Conversion to September 1989 dollars	
Operation and Maintenance for 30 Years	14,309,500
TOTAL	$62,904,655

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[1] Source: Remedy Report for the Hardage Industrial Waste Site, Criner, Oklahoma, October 13, 1989.

boundary of acceptable risk set in the National Contingency Plan.

To accomplish this goal, the remedy would permanently and significantly reduce the volume, toxicity, and mobility of contaminants in the source areas. This is accomplished through removal of liquid contaminants quickly and directly through liquid extraction wells and excavation of drum liquids. By following these steps with soil vapor extraction, removal and destruction of the most mobile contaminants, including most of the known and suspected human carcinogens, will be acheived. The goal of soil vapor extraction would be a 99% reduction of the volatile organic concentrations found at the beginning of soil vapor extraction.

Beyond reduction of the source, the goal of this action is to restore the groundwater to levels below MCLs. This action is particularly directed at the alluvial aquifer assoicated with North Criner Creek.

The superiority of the selected remedy is demonstrated in the comparison of the alternatives through the use of the nine criteria given in Section 7 of this document. The reduction in the sources of the contamination associated with the selected remedy confers advantage to the selected remedy over the remedy recommended by the HSC. By eliminating the contaminants at their source the selected remedy is more protective of human health and the environment, has greater long-term effectiveness and permanence and provides for greater reduction in the volume, toxicity and mobility of contaminants than provided by the HSC remedy. The selected remedy can be implemented using existing technologies and methods. Its cost is greater than that of the HSC proposal, but the selected remedy through its source control elements provides greater and more efficient levels of remediation. In this regard, the additional costs associated with the selected remedy are reasonable. The selected remedy would also comply with existing ARARs on cap construction, which the HSC alternative would not do, and would attain the standards for drinking water quality in the alluvial aquifer as expressed through the Safe Drinking Water Act MCLs in a shorter period of time than the HSC proposal would. The State of Oklahoma through its representatives has expressed concerns about the short-term effectiveness of the selected alternative, and some short-term risks do exist. However, these risks have been considered, and they can be controlled or eliminated through the application of prudent engineering and safety techniques. Finally, the local community, through the public comment period on the alternatives expressed a preference for removal and destruction of as great an amount of the contamination as possible from the source areas. The selected remedy provides for far greater direct removal of the source area contaminants than does the HSC proposal.

The selected remedy also holds advantage over the other EPA alternative which included lancing. The lancing techniques have not been used at a hazardous waste site before and therefore their implementability is not as well known as the excavation of drums in the selected remedy. There are also greater uncertainties associated with in-place release of the drummed liquids through lancing that will not exist with the selected excavation program with actual physical removal of the drummed liquids.

9.0 STATUTORY DETERMINATIONS

Under its legal authorities, EPA's primary responsibility at Superfund sites is to undertake remedial actions that achieve adequate protection of human health and the environment. In addition, Section 121 of CERCLA establishes several other statutory requirements and preferences. These specify that when complete, the selected remedial action for this site must comply with applicable or relevant and appropriate environmental laws unless a statutory waiver is justified. The selected remedy also must be cost-effective and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Finally, the statute expresses a preference for remedies which significantly reduce the volume, toxicity, or mobility of hazardous wastes as their principal element. The following sections discuss how the selected remedy meets these statutory requirements.

9.1 Protection of Human Health and the Environment

The remedy seeks remove liquid contaminants quickly and directly through liquid extraction wells and excavation of drum concentrations. By following this removal with soil vapor extraction, removal and destruction of the most mobile contaminants including most of the known and suspected human carcinogens will be acheived.

Along with effective reduction of contaminant sources, the selected remedy protects human health and the environment through intercepting and treating contaminated groundwater with interceptor trenches. The North Criner Creek alluvial aquifer is the nearest groundwater used as a residential water source. The selected remedy provides better protection of human health and the environment as it will achieve the goals for groundwater cleanup more quickly than the HSC proposal. The selected remedy will eliminate uncertainties associated with the continued presence of toxic and mobile volatile contaminants in the source areas by recovering and eliminating contaminants, unlike the HSC alternative which would allow these contaminants to migrate.

9.2 Compliance with Applicable or Relevant and Appropriate Requirements

The elements of the selected remedy would all comply with applicable or relevant and appropriate requirements (ARARs) established for this site. A more complete examination of ARARs can be found in Appendix A. Key among these ARARs are the Safe Drinking Water Act chemical specific requirements known as MCLs (maximum contaminant limits), and the requirements under the Resource Conservation and Recovery Act (RCRA) which relate to the construction of hazardous waste facilities and their closure.

ARARs include:

1) RCRA requirements for landfill closure in 40 CFR 264.111 Subpart G and 264.310 Subpart N which specify cap requirements for landfills;

2) RCRA requirements in 40 CFR 264.117 Subpart G dealing with Post-closure;

3) Requirements under State of Oklahoma Air Regulations requiring use of Best Developed Available Control Technology for treatment of the air from the SVE system.

4) Maximum Contaminant Levels (MCLs) established under the Safe Drinking Water Act;

5) State of Oklahoma maximum acceptable ambient concentrations (MAACs) for air contaminants;

6) Oklahoma Water Quality Standards for discharge to a surface stream.

None of the alternatives would result in rapid restoration of the ground-water within the site to MCLs. However, the selected remedy would accomplish this goal more rapidly than the HSC remedy through the elimination of contaminant sources. The selected remedy would also meet RCRA requirements for the construction of the cap over the source areas; the proposed HSC alternative does not meet these requirements.

9.3 Cost Effectiveness

The selected remedy is cost effective and would cost an estimated 63 million dollars. It includes some 20 million dollars of cost directly related to contaminant source area reductions, through excavation, soil vapor extraction, and liquids extraction. The HSC remedy does not include these costs. This additonal cost is reasonable considering the added long-term protection of human health the environment provided by direct and permanent reductions to the source areas.

9.4 Utilization of Permanent Solutions and Alternative Treatment Technologies.

The selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost effective manner. The amendment of the 1986 ROD, which called for land filling and stabilizing the source soils and sludges, to the new selected remedy of excavation, liquid extraction, soil vapor extraction and capping provides for a permanent solution through additional recovery and treatment of contaminants.

The emphasis in the selected remedy is on the recovery and permanent destruction of the contaminants at the source. This begins with the recovery of the free liquids and the liquids in the buried drums through excavation and liquid extraction, and the subsequent destruction and treatment of these liquids offsite in a permitted Treatment, Storage, and Disposal facility and in the onsite water treatment system. It also includes soil vapor extraction of the Main Pit, Barrel Mound and Sludge Mound to remove volatile organic compounds.

Another aspect of permanence is the reduction of the mobility, toxicity or volume of the wastes. The selected remedy accomplishes all of these goals through removal of contaminants at the source, unlike the HSC alternative which would allow contaminants to migrate out of the source areas.

Through removal and destruction of contaminants by SVE the amended selected remedy provides permanence, particularly when combined with the groundwater collection and treatment elements of the selected remedy. The groundwater portions of the selected remedy utilize permanent solutions through removal and treatment of contaminated groundwater and the destruction of the organic contaminants removed during treatment.

9.5 Preference for Treatment as a Principal Element

Treatment is central to the selected remedy. Treatment is used extensively to address each of the three primary contaminated media. Free organic liquids from the source areas and organic liquids from the excavated drums will be taken offsite for destruction or treatment at an appropriate, permitted Treatment, Storage and Disposal facility. Contaminated soils and sludges that remain following liquids removal and treatment will be consolidated into the three main source areas for treatment with a soil vapor extraction (SVE) system. The goal of the SVE system will be removal of 99% of the volatile organic contaminants from the contaminated soils and sludges. The air from the soil vapor extraction system, and air effluent streams from other remedy components, will be treated onsite with a thermal treatment system, to treat and destroy the contaminants within the air streams. The third major contaminated media is the aqueous liquids including groundwater, aqueous liquids from the buried drums, and surface run-off. All of these liquids will be treated in an an onsite water treatment plant. The water treatment plant will be designed to treat the influent liquids to standards for discharge in accordance with Oklahoma Water Quality Standards.

Additional advantages in the treatment in the selected remedy are gained by treatment of the contaminants in a more concentrated form. This is true of the free and contained liquids in the source areas due to the liquid extraction wells and collection of the free liquids and the excavation of the buried drums. The SVE system will also recover the volatile contaminants from the soils and sludges in the three source areas allowing them to be treated in a concentrated air stream rather than diffused through the soils and sludges. Treatment of the contaminants at their source will also improve the effectiveness of the water treatment system through reduction of contaminant migration to groundwater. The contaminants will be treated before they migrate into the groundwater where they would spread and be diluted.

9.6 Documentation of Significant Changes

The Proposed Plan for the Hardage/Criner site was released for public comment on October 13, 1989. The Proposed Plan identified the use of drum lancing as an option for addressing the buried drums. Comments received during the public comment period indicated particularly strong opposition from the State of Oklahoma to retention of this option. While EPA feels that drum lancing could be implemented, the option of drum lancing and associated U-shaped trench has been deleted from the selected remedy and only excavation is part of the selected remedy.

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EPA, 1988. Design Report - Source Control Remedial Design - Hardage Industrial Waste Site - Criner Oklahoma, November, 1988.

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HSC, 1988. The Hardage Steering Committee's Recommended Source Control Remedy.

HSC, 1989. Second Operable Unit Management of Migration Remedial Investigation Report, ERM-Southwest, May 10, 1989, as amended by EPA Comments.

HSC, 1989. Second Operable Unit Management of Migration Feasibility Report, ERM-Southwest, May 10, 1989, as amended by EPA Comments.

APPENDIX A

EVALUATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

INITIAL SCREENING OF POTENTIAL FEDERAL CHEMICAL-SPECIFIC ARAR'S

Requirement	Prerequisites	Citation	Description	Applicable/Relevant and Appropriate	Comments
Safe Drinking Water Act (SDWA)		(42 USC 300)			
National Primary Drinking Water Standards	Public Water System	40 CFR 141	Establishes health-based standards for public water systems [maximum contaminant levels (MCLs)].	Yes/--	Organic and inorganic contaminants have been detected at the study area.
National Secondary Drinking Water Standards	Public Water System	40 CFR 143	Establishes standards for the aesthetic qualities of public water systems [secondary MCLs (SMCLs)].	No/Yes	SMCLs are not federally enforceable but are intended as guidelines for the states.
Maximum Contaminant Level Goals	Public Water System	Public Law No. 99-339 100 Stat. 642 (1986)	Establishes maximum contaminant level goals (MCLGs) of no known or anticipated adverse health effects.	No/No	MCLGs are non enforceable requirements.
Clean Water Act (CWA)	Waters of the United States	33 USC 1251-1376	Objectives are to restore and maintain the chemical, physical, and biological integrity of the nation's waters.	yes/	Specific requirements are listed under discharge requirements
Water Quality Criteria		40 CFR 131			
Clean Air Act (CAA)					
National Primary and Secondary Ambient Air Quality Standards	Contamination of air affecting public health and welfare	40 CFR 50 (42 USC 7401-7642)	Establishes standards for ambient air quality to protect public health and welfare (including standards for particulate matter and lead).	No/Yes	Air effluent from the treatment systems must meet these standards.
Resource Conservation and Recovery Act (RCRA)	Uppermost aquifer underlying a waste management unit beyond the point of compliance	40 CFR 264.94	Owners/operators of RCRA treatment, storage, or disposal facilities must comply with conditions in the facility permit that are designed to ensure that hazardous constituents entering the groundwater from a regulated unit do not exceed the concentration limits under 264.94 in the uppermost aquifer underlying the waste management area beyond the point of compliance.	Yes/--	The specific properties of the site may be similar enough to these requirements to render them relevant and appropriate.

Note: -- = If a requirement is applicable, it cannot also be relevant and appropriate.

SFR159/1-1

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INITIAL SCREENING OF POTENTIAL FEDERAL LOCATION-SPECIFIC ARAR'S

Requirement	Prerequisites	Citation	Description	Applicable/Relevant and Appropriate	Comments
Resource Conservation and Recovery Act (RCRA)	RCRA hazardous waste, treatment, storage, or disposal	40 CFR 264.18(a)	New treatment, storage, or disposal of hazardous waste prohibited within 61 meters of a fault displaced in Holocene time.	No/No	There are no known faults within 61 meters.
RCRA	RCRA hazardous waste, treatment, storage, or disposal	40 CFR 264.18(b)	Treatment, storage, or disposal facilities within the 100-year flood plain must be designed, constructed, operated, and maintained to prevent washout.	yes/--	Part of the site lies within the 100-year flood plain.
Executive Order on Flood Plains	Action that will occur in a flood plain (i.e., lowlands and relatively flat areas adjoining inland and coastal waters, and other flood-prone areas)	Executive Order 11988	Must take action to avoid or minimize potential harm to flood plains, and restore and preserve natural and beneficial values.	yes/--	Part of the site lies within the 100-year flood plain.
RCRA	Noncontainerized or bulk liquid hazardous waste	40 CFR 264.18(c)	The placement of any noncontainerized or bulk liquid hazardous waste in a salt dome formation, salt bed formation, underground mine, or cave is prohibited.	No/No	There are no salt dome formations, salt bed formations, underground mines, or caves onsite. Disposal in salt dome formations, mines, or caves is not contemplated for this project.
National Archaeological and Historical Preservation Act	Alteration of terrain that threatens significant scientific, prehistorical, historical, or archaeological data	(16 USC Section 469) 36 CFR 65	Must take action to recover and preserve artifacts.	No/No	There are no known scientific, prehistoric, historic, or archaeological artifacts onsite.
Fish and Wildlife Coordination Act	Diversion channeling or other activity that modifies a stream or river and affects fish or wildlife	(16 USC 661 et. seq.) 40 CFR 6.302	Must take action to protect fish or wildlife	yes/--	Discharge to North Criner Creek is planned as part of the remediation
Scenic Rivers Act	Activities that affect or may affect any of the rivers specified in Section 1276(a)	(16 USC 1271 et. seq. Section 7(a)) 40 CFR 6.302(e)	Must avoid taking or assisting in action that will have direct adverse effect on scenic river.	No/No	No action planned at the site will have direct adverse effect on a scenic river.

Note: -- = If a requirement is applicable, it cannot also be relevant and appropriate.

SFR159/1-2

(Continued)

Requirement	Prerequisites	Citation	Description	Applicable/Relevant and Appropriate	Comments
Coastal Zone Management Act	Activities affecting the coastal zone including lands thereunder and adjacent shorelands	(16 USC Section 1451 et. seq.)	Must conduct activities in a manner consistent with approved state management programs.	No/No	The study area is an inland site with no direct access to coastal lands.
Clean Water Act (CWA) Section 404	Oceans and waters of the United States	40 CFR, Subpart M	Action to dispose of dredge material into ocean waters is prohibited without a permit.	No/No	No action to dredge material is proposed at the site.
Marine Protection Resources and Sanctuary Act, Section 103	Oceans and waters of the United States	(33 USC 1251-1376) 40 CFR 230, 231	Action to dispose of dredge material into ocean waters is prohibited without a permit.	No/No	No action to dredge material is proposed at the site.
Historic Sites, Buildings, and Antiquities Act	Existence of natural landmarks	(16 USC 461-467)	Must avoid undesirable impacts upon landmarks.	No/No	There are no landmarks on the National Register of Natural Landmarks on the site.
Rivers and Harbors Act	Activities affecting navigation waters	(33 CFR 320-330) 33 USC 403	Substative requirements of Section 10 must be met if an alternative developed would involve structures or work in or affect navigable waters.	No/Yes	No structure or work in surface stream is planned other than monitoring.
National Historic Preservation Act, Section 106	Property included in or eligible for the National Register for Historic Places	(16 USC 470 et. seq.) 36 CFR 800	Must take action to preserve historic properties owned or controlled by federal agency. Must plan action to minimize harm to National Historic landmarks.	No/No	The site is not included in or eligible for the National Register of Historic Places.
Endangered Species Act of 1973	Critical habitat upon which endangered species or threatened species depends	(16 USC 1531 et. seq.) 50 CFR 200, 50 CFR 402	Must take action to conserve endangered species or threatened species.	No/No	The site is not a critical habitat upon which endangered species or threatened species depend.
Executive Order on Protection of Wetlands	Wetland as defined by Executive Order 11990, Section 7	Executive Order 11990 40 CFR Appendix 6	Must take action to minimize the destruction, loss, or degradation of wetlands.	No/No	The site is not a wetland as defined by Executive Order 11990, Section 7.

Note: -- = If a requirement is applicrble, it cannot also be relevant and appropriate.

SFR159/1-3

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Requirement	Prerequisites	Citation	Description	Applicable/Relevant and Appropriate	Comments
Wilderness Act	Federally owned area described as a wilderness area	50 CFR 35.1 *et. seq.*	Area must be administered in such a manner that will leave it unimpaired as wilderness and to preserve its wilderness character.	No/No	The site is not a federally owned area described as a wilderness area.
National Wildlife Refuge System	Area designated as part of the National Wildlife Refuge System	50 CFR Part 27, (16 USC 668 d.d. *et. seq.*)	Only actions that are allowed under the provisions of 16 USC, Section dd(c) may be undertaken in areas that are part of the National Wildlife Refuge System.	No/No	The site is not designated as part of the National Wildlife Refuge System.

Note: -- = If a requirement is applicable, it cannot also be relevant and appropriate.

INITIAL SCREENING OF POTENTIAL FEDERAL ACTION-SPECIFIC ARARs

Requirement	Prerequisites	Citation	Description	Applicable/Relevant and Appropriate	Comments
Solid Waste Disposal Act		(42 USC 6901-6987)			
Criteria for Classification of Solid Waste Disposal Facilities and Practices	Disposal of solid waste	40 CFR 257	Establishes criteria for use in determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on health or the environment and, thereby, constitute prohibited open dumps.	No/Yes	However, the more stringent provisions of 40 CFR 260 supercede these criteria.
Hazardous Waste Management System: General	RCRA hazardous waste	40 CFR 260	Establishes procedures and criteria for modification or revocation of any provision in 40 CFR 260-265.	No/No	No modifications or revocations are needed; existing regulations will be used.
Identification and Listing of Hazardous Waste	Solid waste	40 CFR 261	Defines those solid wastes that are subject to regulation as hazardous wastes under 40 CFR 262-265, and 124, 270, and 271.	No/Yes	Are relevant and appropriate if any solid waste residues are generated as a result of treatment.
Standards Applicable to Generators of Hazardous Waste	Generation of RCRA hazardous waste	40 CFR 262	Establishes standards for generators of hazardous waste.	No/Yes	Are relevant and appropriate if there is hazardous solid or liquid residues from treatment plant.
Standards Applicable to Transporters of Hazardous Waste	Generation of RCRA hazard waste with offsite disposal	40 CFR 263	Establishes standards that apply to persons transporting hazardous waste within the U.S. if the transportation requires a manifest under 40 CFR 262.	Yes/--	Applicable to off-site transport of recovered liquids or if there is hazardous residues from the treatment systems.
Standards Applicable to Owners/Operators of Hazardous Waste Treatment, Storage and Disposal Facilities	RCRA hazardous waste	40 CFR 264	Establishes minimum national standards that define the acceptable management of hazardous waste for owners and operators of facilities that treat, store, or dispose of hazardous waste.	Yes/--	Applicable to treatment facility.
o General Facility Standards	Treatment, storage, or disposal of RCRA hazardous waste onsite	Subpart B	N/A	No/Yes	Are relevant and appropriate for onsite treatment facility.
o Preparedness and Prevention	Generation or treatment, storage, or disposal of RCRA hazardous waste onsite	Subpart C	N/A	No/Yes	Treatment facility needs a properly developed and implemented plan for worker safety.
o Contingency Plan and Emergency Procedures	Generation or treatment, storage, or disposal of RCRA hazardous waste onsite	Subpart D	N/A	No/Yes	Establishes normal safety plans and procedures.
o Manifest System Recordkeeping and Reporting	Generation or treatment, storage, or disposal of RCRA hazardous waste onsite	Subpart E	N/A	Yes/--	Are applicable if hazardous solid and liquid residues from treatment plant must be transported offsite.
o Releases from Solid Waste Management Units	Generation or treatment, storage, or disposal of RCRA hazardous waste onsite	Subpart F	N/A	No/Yes	Groundwater monitoring provisions are relevant and appropriate.
o Closure and Post-Closure	Generation or treatment, storage, or disposal of RCRA hazardous waste onsite	Subpart G	N/A	Yes/--	Portions of Subpart G that deal with post-closure activities are applicable.

Note: -- = If a requirement is applicable, it cannot also be relevant and appropriate.

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(Continued)

Requirement	Prerequisites	Citation	Description	Applicable/Relevant and Appropriate	Comments
o Financial Requirements	Generation or treatment, storage, or disposal of RCRA hazardous waste onsite	Subpart H	N/A	Yes/--	
o Use and Management of Containers	Management of RCRA hazardous waste in containers	Subpart I	N/A	Yes/--	Applicable for any containerized waste generated as a result of the RI.
o Tanks	Management of RCRA hazardous waste in tanks onsite	Subpart J	N/A	Yes/--	Same as Subpart I.
o Surface Impoundments	Management of RCRA hazardous waste in surface impoundments onsite	Subpart K	N/A	Yes/--	Applicable to surface impoundments constructed to hold hazardous waste.
o Waste Piles	Management of RCRA hazardous waste in waste piles onsite	Subpart L	N/A	No/No	Waste piles are not being used at this site.
o Land Treatment	Land treatment of RCRA hazardous waste onsite	Subpart M	N/A	No/No	Land treatment is not being proposed for use at this site.
o Landfills	Landfilling of RCRA hazardous waste onsite	Subpart N Part 264.310	Establishes standards for hazardous waste landfills (including cap requirement)	Yes/--	Closure of landfill
o Incinerators	Incineration of RCRA hazardous waste onsite	Subpart O	N/A	Yes/--	The specific properties of the site may be similar enough to these requirements to render them relevant and appropriate.
o Miscellaneous Units	Treatment, storage, or disposal of miscellaneous units	Subpart X		No/No	None are identified at this site.
Interim Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities		40 CFR 265	Establishes minimum national standards that define the acceptable management of hazardous waste during the period of interim status and until certification of final closure or, if the facility is subject to postclosure requirements, until postclosure responsibilities are fulfilled.	No/No	This is not an interim-status facility.
Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities	Recyclable materials that are reclaimed to recover precious metals	40 CFR 266	Establishes requirements that apply to recyclable materials that are reclaimed to recover economically significant amounts of precious metals.	No/No	This is not a recycling facility to recover precious metals.
Interim Standards for Owners and Operators of New Hazardous Waste Land Disposal Facilities	New RCRA hazardous waste land disposal facility	40 CFR 267	Establishes minimum national standards that define acceptable management of hazardous waste for new land disposal facilities. Also establishes standards for underground injection of hazardous wastes.	No/No	A new hazardous waste land disposal facility is not being proposed. Underground injection of hazardous wastes is not contemplated.
Land Disposal Restrictions	Land disposal of RCRA hazardous waste onsite or offsite	40 CFR 268	Prohibits land disposal of specified untreated hazardous wastes and provides special requirements for handling such wastes.	No/No	No untreated wastes are contemplated for disposal.
Hazardous Waste Permit Program	RCRA hazardous waste treatment, storage, and disposal onsite	40 CFR 270	Establishes provisions covering basic EPA permitting requirements.	No/No	Permits are not required for onsite activities at Superfund sites.

Note: -- = If a requirement is applicable, it cannot also be relevant and appropriate.

SFD159/003-2

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Requirement	Prerequisites	Citation	Description	Applicable/Relevant and Appropriate	Comments
Underground Storage Tanks (UST)	Underground storage tank	40 CFR 280	Establishes regulations related to underground storage tanks.	No/No	There are no underground storage tanks that are being addressed in this study.
Proposed Regulation for Control of emissions of volatile organics	Volatile organics emissions	52 FR 3748	Proposed standard would require 95% reduction of volatile organic emissions from Product Accumulator Vessel.	Yes/--	If a treatment plant is a product accumulator vessel.
Safe Drinking Water Act (SDWA)		(42 USC 300g)			
Underground Injection Control Regulations (UIC)	Underground injection of substances	40 CFR 144-147	Provides for protection of underground sources of drinking water.	No/No	No injection of liquids is planned at the site.
Clean Water Act (CWA)		33 USC 1251-1376			
National Pollutant Discharge Elimination System	Discharge of pollutants from any point source into waters of the United States	40 CFR 122, 125	Requires permits for the discharge of pollutants from any point source into waters of the United States. Permits based on ambient water quality criteria.	Yes/--	Technology-based treatment requirements that are equivalent to best conventional control technology (BCT) or best available technology economically available (BAT) will be determined by EPA on a site-specific basis.
Effluent Limitations	Point source discharge into the Ore Mining and Dressing Point Source category	40 CFR 440	Sets technology-based effluent limitations for point source discharges in the Ore Mining and Dressing Point Source category.	No/No	No ore sources have been identified at the site.
National Pretreatment Standards	Pollutants that pass through or interfere with treatment processes in POTWs or that may contaminate sewage sludge.	40 CFR 403	Sets standards to control pollutants that pass through or interfere with treatment processes in POTWs or that may contaminate sewage sludge.	No/No	No discharge to a Public Sewage Treatment Plant is planned at the site.
Toxic Pollutant Effluent Standards	Aldrin/dieldrin, DDT, endrin, toxaphene, benzidene, PCBs	40 CFR 129	Establishes effluent standards or prohibitions for certain toxic pollutants.	Yes/--	If these contaminants exist within the study area.
Marine Protection Research and Sanctuaries Act	Ocean dumping	(33 USC 1401-1445)	Regulates ocean dumping.	No/No	Ocean dumping not part of any proposed alternatives.
Toxic Substances Control Act (TSCA)	PCBs	(15 USC 2601-2629) 40 CFR 761	Establishes storage and disposal requirements for PCBs.	Yes/--	Applicable if PCBs are detected in materials being transported off-site or treated above action levels.
Surface Mining Control and Reclamation Act (SMCRA)	Mining operations	(30 USC 1201-1328)	Establishes provisions designed to protect the environment from the effects of surface coal mining operations and, to a lesser extent, noncoal mining.	No/No	Study area is not a mining-related site.
Clean Air Act (CAA)		(42 USC 7401-7642)			
National Emission Standard for Hazardous Air Pollutants	Hazardous air pollutants	40 CFR 61	Sets emission standards for designated hazardous pollutants, including mercury, beryllium, and inorganic arsenic.	No/Yes	Some portions of 40 CFR 61 would be relevant and appropriate to off-gas emissions from the treatment systems.

Note: -- = If a requirement is applicable, it cannot also be relevant and appropriate.

(Continued)

Requirement	Prerequisites	Citation	Description	Applicable/Relevant and Appropriate	Comments
National Ambient Air Quality Criteria	Various air contaminants		Sets emission standards for designated air contaminants to protect the public health and welfare.	Yes/--	All proposed alternatives need to provide adequate level of workers protection during remediation.
New Source Performance Standards	New stationary source		Sets emission standards for certain classes of new stationary sources of air pollution.	Yes/--	If a certain class of new source is proposed as part of treatment plant.
Occupational Safety and Health Act (OSHA)	Remedial action workers	(29 USC 651-678)	Regulates worker health and safety.	Yes/--	Applicable to worker health and safety.
Federal Mine Safety and Health Act	Work in underground mines	30 USC 801-962	Regulates working conditions in underground mines to assure safety and health of workers.	No/No	Study area is not a mining-related site.
Hazardous Materials Transportation Act		(44 USC 1801-1813)			
Hazardous Materials Transportation Regulations	Transportation of hazardous materials	40 CFR 107, 171-177	Regulates transportation of hazardous materials.	Yes/--	If any alternative requires the offsite transportation of hazardous materials.

Note: -- = If a requirement is applicable, it cannot also be relevant and appropriate.

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Requirement	Prerequisites	Citation	Description	Applicable/Relevant and Appropriate	Comments
Oklahoma Water Quality Standards (OWQS)		82 O.S. Supp. 1988 926.3, 926.6, 1085.2	Promote & protect as many beneficial uses as are attainable and to assure that degradation of existing quality of waters does not occur.	yes/--	Application depends on the designated beneficial use of the stream
Surface Water Quality Standards		OWQS 300	to provide that no waste be discharged into any waters of the State without first being given the degree of treatment necessary to protect the legitimate beneficial uses of such waters.	yes/--	See specific requirements.
Public & Private Water Supplies	Designated use by OWQS.	OWQS 300.5	Criteria for water quality.	no/yes	Criner Creek is designated as a public & private water supply.
Primary Warm Water Fishery	Designated use by OWQS.	OWQS 300.7	Criteria to promote fish and wildlife propagation.	yes/--	Both North Criner Creek and Criner Creek are designated for fish and wildlife propagation.
Agriculture	Designated use by OWQS.	OWQS 300.8	Surface waters maintained so that toxicity does not inhibit continued ingestion by livestock or irrigation of crops.	yes/--	Both Criner Creek and North Criner Creek are designated for beneficial use by agriculture.
M & I Process Water	Designated use by OWQS.	OWQS 300.10	Quality criteria for water used for process or cooling purposes.	yes/--	Both Criner Creek and North Criner Creek are designated for use as M&I process water.
Primary Recreation and Secondary Recreation	Designated use by OWQS	OWQS 300.11	Water shall not contain substances in concentrations that are irritating to skin or are toxic or cause illness upon ingestion.	yes/--	North Criner Creek is designated for secondary body contact recreation and Criner Creek for primary recreation.
Aesthetics	Designated use by OWQS	OWQS 300.14	Surface Waters are to be aesthetically enjoyable.	yes/--	Both Criner Creek and North Criner Creek are affected by aesthetic standards.
Groundwater Quality Standards		OWQS 400			
Protective Measures	fresh groundwater	OWQS 400.2	Protective criteria for ground water.	no/no	Not a major ground water basin
Oklahoma Clean Air Act		63 O.S. Supp. 1981 1-1801 et seq.			
Control of Emission of Hazardous and Toxic Air Contaminants.		Regulation 3.8	Control of emissions of hazardous and toxic contaminants.	yes/--	New source of hazardous or toxic emissions.
Control of Fugitive Dust		Regulation 3.1	Control visible emissions and particulates.	yes/--	
Control of smoke, visible emissions and particulates.		Regulation 3.3	Take reasonable precautions to minimize atmospheric pollution.	yes/--	

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APPENDIX B

AGENCY FOR TOXIC SUBSTANCES DISEASE REGRISTRY EVALUATION

Health Assessment for

ROYAL HARDAGE INDUSTRIAL HAZARDOUS WASTE LAND DISPOSAL FACILITY

CRINER, OKLAHOMA

DECEMBER 1988

SUMMARY

The Royal Hardage Industrial Hazardous Waste Land Disposal Facility (Hardage/Criner) National Priorities List (NPL) Site is located in Criner, McClain County, Oklahoma. The site is located in an agricultural area. There are volatile organic compounds (VOC's) and several heavy metals present in the groundwater and soil, and VOC's in surface water and sediment. The Record of Decision (ROD) for the first operable unit (source control) signed November 1986, selected several remedial actions which included excavation of the primary source material and separation of the wastes for treatment: solids to be disposed of in an on-site landfill which meets Resource Conservation and Recovery Act (RCRA) requirements, organic liquids to be incinerated, and inorganic liquids to be treated by other means as necessary. This site is currently in the remedial design phase.

BACKGROUND

A. SITE DESCRIPTION

The Hardage/Criner NPL Site is located in McClain County, Oklahoma, on 60 acres. Operations began at the facility in 1972. Several pits were excavated in the early years to receive wastes from barrels and tank trucks. The pits filled rapidly. The wastes were then transferred to temporary ponds. In the west pond, the wastes were slurried with soil and transferred to the south pond. The south pond was eventually filled and the wastes were then stacked to a height of 10 feet above grade. This became known as the sludge mound (see Appendix).

During the mid-1970's, drums were no longer emptied into the pits, instead they were piled at the north end of the main pit. This became known as the drum mound (see Appendix). During the late 1970's monitoring wells were constructed in the southwest corner of the site. These wells indicated the presence of contamination.

The wastes received by the facility included: oil recycling wastes, chlorinated solvents, styrene tar, acids, caustics, paint sludges, lead, chromium, cyanide, arsenic, pesticides, inks, polychlorinated biphenyl's (PCB's) and large quantities of waste from injection wells and other nearby facilities including two NPL sites, Brio and Bio Ecology.

Operations ceased in November 1980. Closure activities continued into 1982. There was an effort made during the closure activities to consolidate the wastes into major source areas. These source areas are identified in the Appendix.

The ROD for the first operable unit signed November 1986, selected several remedial actions which included excavation of the primary source material and separation of the wastes for treatment: solids to be disposed of in an on-site landfill which meets RCRA requirements, organic liquids to be incinerated, and inorganic liquids to be treated by other means as necessary. This is presently in the design phase. A second Remedial Investigation (RI) was begun in February 1988 to determine what type of migration control should be implemented at this site.

B. SITE VISIT

ATSDR has not conducted a site visit at this time.

ENVIRONMENTAL CONTAMINATION AND PHYSICAL HAZARDS

A. ON-SITE CONTAMINATION AND OFF-SITE CONTAMINATION

The project site boundary depicted in the Appendix was the basis for defining on-site and off-site in this Health Assessment. The values recorded in the tables below reflect the data presented in the Field Investigation and Data Summary Report, Volume 1. Although there were other data received by ATSDR, sampling points were not adequately identified, and therefore, were not utilized in the tables.

The results for the surface water and sediment sampling recorded in Appendix H of the Field Investigation and Data Summary Report were not provided to ATSDR for review. However, the discussion provided in the text indicated that methylene chloride and bis (2-ethylhexyl) phthalate (DEHP) were detected in the surface water samples and methylene chloride, fluorotrichloromethane, DEHP, and chloroform were detected in the sediment. (These contaminants may be laboratory artifacts and not site-related.)

Table 1
ON-SITE CONTAMINATION

Contaminants	Soil (mg/Kg)	Groundwater (ug/L)
Chloroform	ND--.0006	3--40
1,2-Dichloroethane	ND--.180	ND--1,500
1,1-Dichloroethene	ND--6.2	10--5,300
Tetrachloroethene	ND--16,000	ND--1,800
1,1,1-TCA	ND--6,000	33--32,000
1,1,2-TCA	ND--1,100	ND--1,200
Trichloroethene	ND--1,500	29--36,000
trans-1,2-DCE	ND--.009	10--46,000
1,2-DCB	ND--150	ND--4,300
DDT	--	ND--57
Chromium	ND--937	ND--28
Lead	ND--5,470	--
Methylene Chloride	ND--1,300	24--49,000
Xylene (total)	ND--1,500	--
Toxaphene	ND--160	--
Aroclor 1260	ND--19	--

Table 2
OFF-SITE CONTAMINATION

Contaminants	Monitoring (ug/L)	Residential (ug/L)
Chloroform	ND--1,300	--
1,2-Dichloroethane	ND--140,000	--
1,1-Dichloroethene	ND--4,900	ND--6.6
Tetrachloroethene	ND--24,000	ND--9.2
1,1,1-TCA	ND--31,000	ND--29
1,1,2-TCA	ND--50,000	ND--120
Trichloroethene	ND--8,000	ND--63
trans-1,2-DCE	ND--3,600	ND--79
1,2-DCB	ND--40	--
Chromium	ND--223	--
Lead	ND--23	ND--23

Legend

TCA trichloroethane
DCE dichloroethene
DCB dichlorobenzene
DDT dichlorodiphenyltrichloroethane
-- no concentration reported

B. PHYSICAL HAZARDS

There are no reported physical hazards present at this site.

DEMOGRAPHICS OF POPULATION NEAR SITE

The area surrounding the site is used to graze cattle. A chain-link fence was installed in 1987 which eliminated the past problem with cattle grazing on-site. There are two buildings located on-site. One was the former sludge drying building located northeast of the drum mound. The other was a barn located between the sludge mound and the main pit, which was used as an office. The site is located 15 miles southwest of Norman, Oklahoma, and one-half mile east of the community of Criner. The nearest residence is located along the southwest site boundary.

EVALUATION

A. SITE CHARACTERIZATION (DATA NEEDS AND EVALUATION)

1. Environmental Media

The soil contamination has been well defined. The groundwater and surface water, and the interactions between them, will need to be more completely characterized in the future to determine public health implications. This further characterization should be addressed in the second operable unit (migration control) RI. A drinking water survey should be conducted and a map developed which indicate the location and population using the groundwater (public and private wells) or the surface water.

2. Land Use and Demographics

The land use and demographic data provided to ATSDR were incomplete. Additional information on the current use of residential wells near the site would be useful to ATSDR. If this information does not already exist it should be gathered during the second RI.

3. Quality Assurance/Quality Control

Conclusions contained in this Health Assessment are based on the information received by ATSDR. The accuracy of these conclusions is determined by the availability and reliability of the data.

B. ENVIRONMENTAL PATHWAYS

The bulk of the contamination present on-site is located in the subsurface soil. This contamination is the primary source of the contamination in the other media. The first operable unit ROD requires the excavation of all principal source areas and the appropriate treatment and disposal of such materials. This action should help to decrease the migration of the contamination from these source areas. Additional soil sampling during the second operable unit RI should identify any additional areas of soil contamination.

The groundwater at the site is located in two geologic formations near the site. One formation which is the primary source of drinking water in the area, is the alluvium of North Criner Creek, which is 40 to 60 feet deep at mid-valley. The other formation is the Hennesey Formation which is composed of fractured shale, mudstone, and sandstone. The water located in the upper sediments is potable, but deeper it becomes salty and brackish.

The flow of the groundwater has not been well defined at this time. It appears to flow to the southwest and the east. Leachate has been detected up to 50 feet below the bedrock as well as 400 to 2,000 feet laterally in the bedrock. This is a result of the strong downward gradient and the fractured Hennesey Formation. Contamination has also been detected in the alluvium of North Criner Creek 2,000 feet southwest of the site. The plume is estimated to be 1,000 feet long. The mechanism of this transport is unknown and will be the subject of further study during the second operable unit RI.

The North Criner Creek flows from the northwest to the southeast and is located south of the site. Its alluvial valley extends almost to the southwest corner of the site. North Criner Creek joins Criner Creek approximately 1 mile south of the site. There is also a creek located about 400 feet east of the waste disposal areas. This stream was impounded to create 3 small lakes which cover approximately 6 acres, total. There is a 2-acre pond located 1,500 feet west of the drum mound. Surface water and sediment samples were taken at various locations at the site. These samples indicated the presence of contamination. The additional sampling planned for the second operable unit RI should include surface water and sediment samples to better characterize those media.

There was no ambient air sampling conducted at this site. Without any data to the contrary, air must be considered a potential medium of concern.

Potential environmental pathways at this site include migration of contamination from the primary source areas and the soil to the groundwater, surface water and sediment, biota, and air. There is also the potential for the contamination to migrate between the various media.

C. HUMAN EXPOSURE PATHWAYS

The potential human exposure pathways for this site are ingestion of contaminated soils, groundwater, and surface water; inhalation of dusts or vapors from the source areas, the contaminated soil, or the contaminated groundwater; and dermal exposure to contaminated soil, groundwater, surface water, or sediment.

Inhalation of dusts and vapors generated on-site from the soils is a potential exposure pathway for remedial workers and trespassers at the site. People may be exposed to contamination while performing tasks that require disruption of the soil, thereby causing a release of contaminated dust and vapors. This potential exposure will decrease once remedial work requiring excavation of the contaminated soil and construction of the on-site landfill is complete. Off-site there is a potential for exposure from fugitive dusts and vapors generated by disrupting the soil at the site, and inhalation of vapors generated while using the contaminated groundwater could occur if water from contaminated wells was used for showering, irrigation, washing cars, etc.

Ingestion of contaminated groundwater is a potential public health concern, off-site. The maximum concentration of trichloroethylene (TCE) (63 ug/L), and trans-1,2-DCE (120 ug/L) reported in Table 2 above, were detected in a residential well that was no longer in use at the time of the sampling. However, the maximum concentration of lead (23 ug/L) reported, was detected in a residential well which was still in use. This concentration of lead is of public health concern. According to the Environmental Protection Agency these homes have been provided alternate water. There is no known use of the groundwater on-site. The concentrations of contaminants detected in the groundwater monitoring wells located on-site are of public health concern and the water should not be used for domestic or agricultural purposes.

Ingestion of soil is a potential human exposure pathway on-site. The problem will center around the workplace (people eating lunch with dirty hands, wiping dirt on their face, etc.). Dermal exposure is a potential human exposure pathway from working with the contaminated soils, especially in the locations of the primary source areas. This potential exposure will decrease once the contaminated soils are contained within the landfill.

There is a possibility of incidental ingestion and dermal exposure to surface water and sediments at the site. The surface water features in the area may be used for recreational activities (e.g., wading, fishing, etc.).

Human exposure pathways that are of public health concern are inhalation of fugitive dusts and vapors generated on-site and vapors generated from use of groundwater off-site; ingestion of contaminated soils, surface water, and groundwater; and dermal absorption of contamination from soil, sediments, surface water, and groundwater.

PUBLIC HEALTH IMPLICATIONS

Much of the contamination detected in the various media are VOC's. Some of these VOC's may cause depression of the central nervous system at high concentrations. Also, some VOC's cause liver and kidney toxicity as well as damage to the pulmonary and hematopoietic systems. In addition, there is evidence that some VOC's are carcinogenic in laboratory animals.

TCE given orally in doses of 24 or 240 mg/kg/d for a period of 14 days produced effects including increased liver weight, decreased hematocrit, and depressed cell-mediated immune response (Tucker et al., 1982, Sanders et al., 1982). Based on liver tumor production in mice, the Environmental Protection Agency (EPA) has designated TCE as a potential human carcinogen. It is unknown how long residents may have been drinking or using for domestic purposes the highly contaminated water present in the plume. Long-term exposure to TCE at the maximum contamination detected in residential wells could result in a significant, increased risk of cancer and other non-carcinogenic toxic effects such as liver damage and depression of immune function. Therefore the use of this groundwater for drinking, bathing, and other domestic uses is not acceptable.

Lead is known to cause neurological effects in gestating fetuses, neonates, and young children. It can also cause peripheral neuropathy in adults. Other adverse health effects caused by lead include: hypertension, growth retardation, and effects on heme synthesis enzymes and the cell membrane. The maximum concentration of lead detected in the soil at this site was 5,470 mg/Kg and in the residential wells, 23 ug/L. Ingestion of lead at these concentrations is of public health concern.

Acute PCB-related health effects typically occur at higher concentrations than those detected on-site. However, for this site, the primary identified potential health effects, resulting from exposure to PCB's through ingestion, inhalation, and dermal contact, are carcinogenic effects. PCB's, have been designated as Group B2--Probable Human Carcinogens (EPA 1987). This designation is based on experiments which demonstrated the induction of hepatocellular carcinomas in laboratory animals fed high doses of PCB's in their diet (Kimbrough et al., 1975; Norback and Weltman, 1985).

The toxicity of chromium is dependent upon the valence of the cation present (Cr VI or Cr III) and the anion to which it is bound. The valance of the chromium detected at the site was not established; therefore, this assessment is based on the potential toxic effects of Cr VI, which is the more toxic form. The cell membrane is penetrated by Cr VI more easily than Cr III. Once inside the cell, Cr VI is converted to Cr III, which then complexes with deoxyribonucleic acid (DNA) providing an opportunity for cell mutation (EPA 1987). Dermal contact with Cr VI may result in dermatitis or skin ulceration. Chromium can also cause kidney and liver damage. The maximum concentration found in the soil was 937 mg/Kg. Ingestion of chromium at this concentration is of public health concern.

CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

This site is of potential health concern because of the risk to human health resulting from possible exposure to hazardous substances at concentrations that may result in adverse health effects. As noted in the Environmental Pathways and Human Exposure Pathways Sections, human exposure to contaminated soil, groundwater, surface water, sediment, air, and biota may have occurred in the past or may be occurring now. The actions in the ROD should reduce the potential exposures to the soil and should reduce the potential for the migration of contamination from the source. The second operable unit RI should provide the additional information required to determine what migration controls should be implemented at the site.

B. RECOMMENDATIONS

1. During remediation, measures should be taken to protect people on-site and off-site from exposure to any dusts or vapors that may be released. Workers on-site should be provided adequate protective equipment and training, in accordance with 29 CFR 1910.120, and should follow appropriate National Institute for Occupational Safety and Health and Occupational Safety and Health Administration guidelines, when involved in activities that may result in an exposure. Workers should implement optimal dust control measures. During working hours, appropriate monitoring should be utilized at the worksite periphery to protect nearby workers and residents.

2. The information requested in the Data Needs and Evaluation Section of this Health Assessment should be provided to ATSDR.

3. In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act as amended, Hardage/Criner NPL Site has been evaluated for appropriate follow-up with respect to health effects studies. Although there are indications that human exposure to on-site or off-site contamination may have occurred in the past, this site is not being considered for follow-up health studies at this time because the level and extent of possible human exposure to site chemicals has not been defined and it is unclear that current exposure is occurring. However, if data become available suggesting that human exposure to significant levels of hazardous substances is currently occurring or has occurred in the past, ATSDR will reevaluate this site for any indicated follow-up.

PREPARERS OF REPORT

Environmental Reviewer: Susan L. Mueller, Environmental Health Specialist, Health Sciences Branch.

Regional Representative: Carl Hickam, ATSDR Regional Representative, Region VI.

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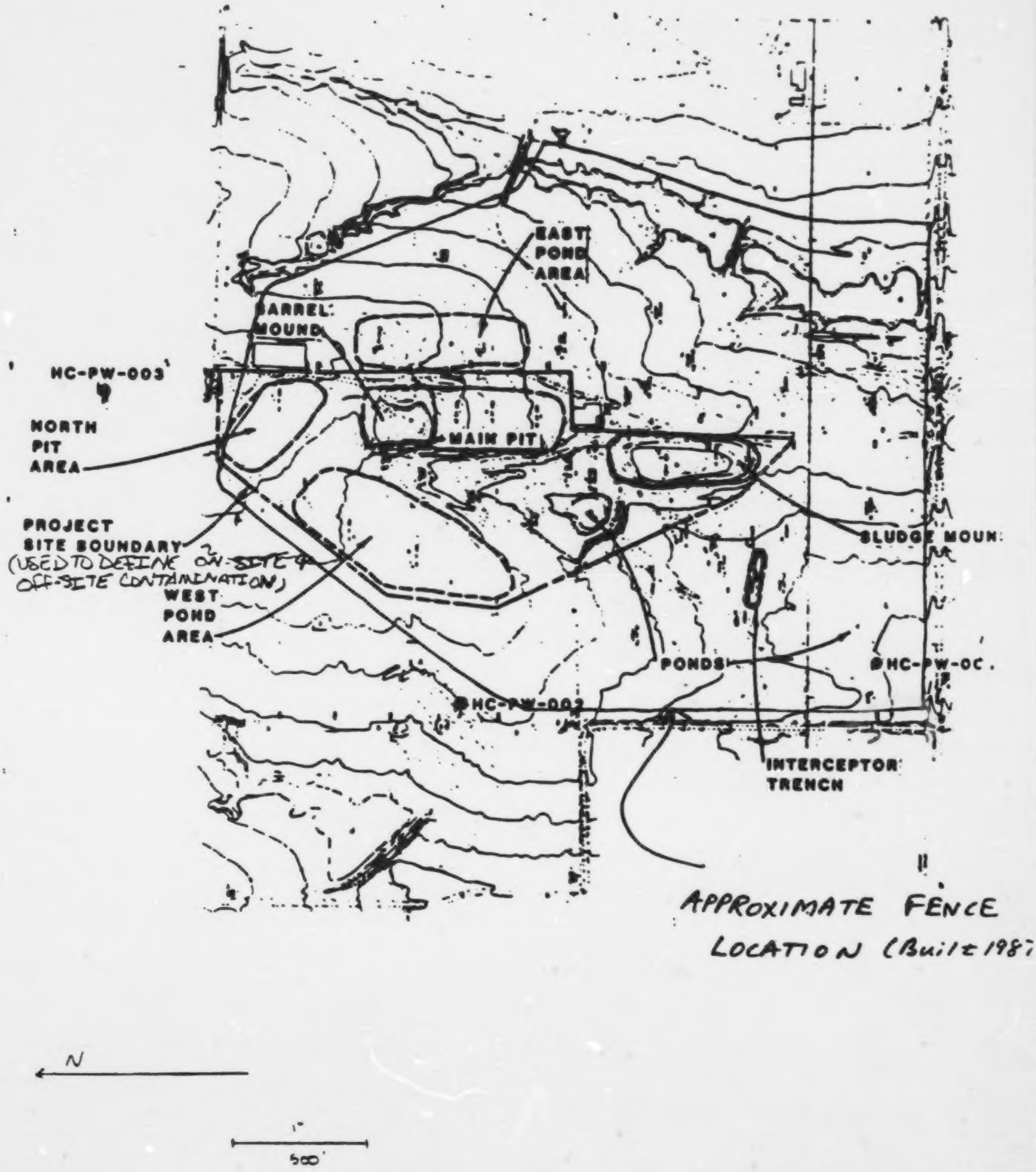
APPENDIX


EAST POND AREA
BARREL MOUND
HC-PW-003
NORTH PIT AREA
MAIN PIT
PROJECT SITE BOUNDARY
(USED TO DEFINE ON-SITE & OFF-SITE CONTAMINATION)
WEST POND AREA
SLUDGE MOUN
PONDS
HC-PW-OC
HC-PW-002
INTERCEPTOR TRENCH
N
1"
500'

APPROXIMATE FENCE LOCATION (Built 198

26,438A

PURCELL SERIES WELLS

HARDAGE/CRINER SITE OK-86

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APPENDIX C

ADMINISTRATIVE RECORD INDEX
(with Addendum)

Administrative Record Index
not included.

APPENDIX D

STATE OF OKLAHOMA CORRESPONDENCE

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OKLAHOMA CITY, OK 73152

AN EQUAL OPPORTUNITY EMPLOYER

November 13, 1989

Allyn M. Davis, Ph.D (6H)
Director
Hazardous Waste Management Division
EPA Region VI
1445 Ross Ave.
Dallas TX 75202

Dear Dr. Davis:

I was surprised to receive your letter requesting concurrence on the Hardage/ Criner Proposed Remedial Action Plan. We were awaiting additional information and we were given only one working day to formulate a reply.

Please be advised that the discussions we have had with representatives of your agency have not served to eliminate several of our concerns regarding your proposed plan. As you are aware, the Oklahoma State Department of Health (OSDH) received the Remedy Report for the Hardage Industrial Waste Site on October 13, 1989 and subsequently requested briefings in order to gain an appreciation of your proposal. During the briefings your staff was unable to answer any of our questions relative to risk analysis, condition of the barrels and amount of liquids in barrels. Additionally, only some of our concerns relative to control of air emissions and other basic information and assumptions upon which the proposed plan is built were answered.
Your staff promised to forward information relative to some of these issues; however, the information received was either unconvincing or not pertinent to these issues. The important question of relative risk has been left unanswered.

OSDH believes that several of the remedial action technologies proposed for site clean up have merit and in the interest of public health should be instituted as soon as practicable.

elements of merit:
- Southwest trench or wells - institute immediately
- V-shaped trench - institute immediately
- Liquid extraction wells
- Vapor extraction wells - if this element is part of a permanent cap with a vapor control component.

OSDH also believes that there are serious problems with several proposed clean up technologies presented in the Remedy Report and that these elements of the plan have potential for increasing health risks to the public.

elements of disagreement:

Drum lancing - not recommended
Excavation of drums - not recommended
U-shaped trench - not recommended
Catalytic thermal treatment - as presented will not meet CAA requirements or BACT.

The Oklahoma State Department of Health does not agree with significant elements of EPA's Remedial Action plan for the Hardage/Criner Superfund site as presented and explained to us, therefor, OSDH cannot concur with the proposed plan based on the information currently available.

If you have any questions regarding this matter please call me at (405) 271-8056.

Very truly yours,

Mark S Coleman

Mark S. Coleman
Deputy Commissioner
for Environmental Health

APPENDIX E

RESPONSIVENESS SUMMARY

Hardage/Criner Site
Community Relations Responsiveness Summary

The Community Relations Responsiveness Summary has been prepared to provide written responses to comments submitted regarding the proposed plan at the Hardage/Criner hazardous waste site. The summary is divided into two sections:

Section I: Background of Community Involvement and Concerns. This section provides a brief history of community interest and concerns raised during the remedial planning activities at the Hardage/Criner site.

Section II: Summary of Major Comments Received. The comments (both oral and written) are summarized and EPA's responses are provided.

I. Background of Community Involvement and Concerns

Individual interest or attention to the site has been moderate since the signing of the 1986 Record of Decision for source control. Individual residents are concerned about their health, food chain impacts, as well as the economy of the area. Residents at the public meeting in October of 1989 indicated their desire for more frequent updates on activities and plans for the site, and for credibility of the remediation through the removal of wastes from the site.

II. Summary of Major Comments Received

Public notice announcing the public comment period and opportunity for a public meeting was given on October 1, 1989. The Proposed Plan fact sheet was distributed to the site mailing list on October 12, 1989. Fact sheets were also sent to site repositories on this date, along with documents comprising EPA's Administrative Record for the site. The comment period began on October 13 and ended on November 2, 1989. A public meeting was held on October 26, 1989, at the Grady County Fairgrounds Community Building in Chickasha. The purpose of this meeting was to explain the results of the Remedial Investigation and Feasibility Study for groundwater, and to explain changes in the source control remedy since the 1986 Record of Decision for the site. Approximately 40 people were in attendance, and a number of questions and comments were received. Two letters were received with questions as well.

The comments/questions received during the public comment period concerned the following

- the timing and exact location of remedial activities
- the impact of contaminated groundwater on the food chain and health
- safety and health concerns during remediation
- the location and announcement of future public meetings.
- need for the excavation of drums

Comments were received from the following citizens: Marvin Lyles, Edwin Kessley, Royce Smith, Eilene Whitehead, Kay Hixon and George (Buddy) McKinnon. Letters were received from George McKinnon and Lisa Ozment with Progressive Environmental Management, Inc. Comments received are summarized below, along with EPA responses.

Question #1. Will there be any problems with the roads due to movement of equipment?

Response: The majority of the activities at the site during remediation will take place within the site boundaries. There will be some movement of equipment onto the site to perform the work. The only regular movement will be the shipment of the liquids removed from the source areas as they are taken offsite to be destroyed. These liquids will be accumulated until a load is ready for shipment.

Question #2. Why weren't the source areas covered during the time of the investigations to prevent the infiltration of rainwater?

Response: Actions were taken to eliminate immediate threats at the site, such as erosion of the Barrel Mound. From the end of 1982 when the Hardage property became a Superfund site it was not anticipated that it would take as long as it has for clean-up to begin. This is particularly true of the delay for litigation which has taken place since 1986.

Question #3. Why are there differences in the locations shown for the southwest trench locations in the fact sheet and the overhead during the presentation?

Response: Trench or interceptor well locations shown on overheads during the presentation were only approximate locations specified for the purpose of evaluating alternatives for groundwater control. The trench or interceptor well locations specified in the fact sheet are also approximate and based on the current spread of groundwater contamination. The exact location of the proposed interceptor system will be determined during final design stages of the project, and will be based on the following considerations:

a) the spread of groundwater contamination immediately upgradient of the alluvium;

b) the hydraulic properties of the bedrock (these dictate the exact design requirements); and

c) the location of residential structures and property.

EPA will make efforts to install the interceptor system so as to minimize disruption to homeowners who may be impacted by construction and operation and maintenance activities.

Question #4. Did all of the EPA's information come from the Hardage Steering Committee's investigation or did EPA do its own studies.

Response: Much of the information about the Hardage site has come from multiple sources. EPA, the Oklahoma State Department of Health (OSDH), and the Hardage Steering Committee (HSC) have all gathered information about the site. The most recent investigation, that of the area groundwater, was conducted by the Hardage Steering Committee under the terms of a formal agreement with EPA. Among the terms of the agreement were provisions for EPA oversight of the work, split sampling by EPA to check the HSC's sample results, and EPA review and comment upon the investigation reports, and final EPA approval. EPA has its own experts and employees to examine the information gathered and is not dependent upon the interpretations put on the raw information by the HSC.

Question #5. How deep is the underground water in the area of Mrs. Smith's property?

Response: Water level measurements in the alluvium in this area indicate that the groundwater table is about 15 feet below the ground surface.

Question #6. Is there any threat from eating from pecan trees that have roots into the contaminated groundwater?

Response: Wells in the vicinity of the homestead in question (MW-12, 13, and 28, for example) exhibit detectable concentrations of contaminants. Contaminants detected in the alluvium include the following compounds at the concentrations indicated:

Compound	Concentration Range (parts per billion)	Drinking Water Standard (parts per billion)
Total volatile organics (VOC)	39 - 560	not set
Arsenic	1 - 7	50
Selenium	6 - 52	10

As the table indicates, selenium and VOCs are present at levels which pose a concern for drinking water. Whether these contaminanats are taken-up by pecan tree roots is not known. EPA will search for information on exclusion mechanisms in pecan trees, and further evaluate this question.

Question #7. There were noxious fumes from the site during its operation. What about these fumes?

Response: During the time that the Hardage site was open, much of the waste that was brought to the site was exposed to the air. There were open ponds containing waste and drums and piles of more solid material were also left uncovered. This allowed the fumes to escape from these sources. The potential for escape of fumes is dependent on the surface area of contaminated material which is exposed. During the selected remedy, the major potential for such exposure is during excavation of the drums from the Barrel Mound and the Main Pit. Three direct actions will be taken to control the formation of fumes. First, the excavation will be done on the smallest practical working face. This means that the area disturbed to remove the drums and any one time will be kept at a minimum so that as little contaminated material will be exposed to the air as possible. The second step will be constant monitoring of the air both around the excavations and at the fence line. The third is would be the use of engineering controls to prevent vapor release problems. This would entail the use of foam supressants to stop the escape of the fumes up to stopping operations and recovering the exposed areas if the fumes cannot be controlled.

Question 8. Is EPA aware of a report by Kirk Brown from Texas A & M saying that contamination is worse than EPA says?

Response: One of the government's experts for the purposes of the upcoming trial on the Hardage site is Dr. Kirk Brown. Mr. Brown is therefore representing the government and EPA is in agreement with his opinions, which involve significant measures to directly reduce contamination in the main source areas.

Question #9. When will a final decision be made on what will be done to clean up the site?

Response: The Record of Decision which was issued at the same time as this Responsiveness Summary completes the EPA's administrative process for selecting the clean-up method for the site. There is also a trial on this issue which is scheduled to begin on November 27, 1989 in Federal District Court in Oklahoma City and which should last no more than twenty days. The Judge will then give his decision on remedy.

Question #10. The notice that appeared in the Daily Oklahoman was not sufficient to notify the local residents about the meeting on the site. Notice needs to be provided in papers which the local people use.

Response: The regulations governing the issuing of public notice require that a daily paper be used to give the notice. However, that doesn't prevent the placing of additional notices in other papers. In the future additional papers will be used including the Purcell Register, Chickasha Star, and the Blanchard News.

Question #11. The meeting should have been held in McClain County where the site is and not in Grady County.

Response: Future meetings will be held at a location in Purcell.

Question #12. Will transcripts of the meeting be available to the public?

Response: Yes. A copy of the meeting transcript will be placed in the public repository for the site in the Purcell Public Library, the offices of OSDH in Oklahoma City, and at EPA's offices in Dallas. In addition, copies will be available on request from either Mr. Underwood or Ms. Price at EPA.

Question #13. There are carcinogenic compounds in the water that has been used by the Whiteheads (including children and infants) over the past 14 years. This contamination is moving to Criner Creek, which in turn runs into the Washita. At what rate is it moving?

The Whiteheads were provided alternate water from the McClain County Rural Water District No. 7 in 1987. Prior to this, domestic water supplies came from wells installed in North Criner Creek. Groundwater contamination has migrated to a location in North Criner Creek which is approximately 1600 feet downstream of the North Criner Creek bridge on Old State Highway 122. Groundwater flow rates for the upper alluvium are estimated to be between 80 and 170 feet per year and that for the lower alluvium between 9 and 19 feet per year.

Question #14. How many years until this contamination is contained?

Response: Groundwater contamination will be removed when the groundwater interceptor system and source control components (soil vapor extraction, drum excavation and liquid extraction wells) are installed. Construction is expected to take some five months from start to finish. Construction will begin as soon as the litigation ends and the trench design is approved by EPA.

Question #15. Do we know how much contamination is present in Criner Creek?

Response: We know there are levels of contaminants in the North Criner Creek alluvium (see answer to Question #6). Low levels of contaminants have also been detected in surface water samples of North Criner Creek. Contaminants, however, have not reached Criner Creek.

Question #16. How much time will be needed from the time a decision is made to the start of the clean-up?

Response: Once a decision has been made (see Response to Question #9) it normally takes about nine months for clean-up to begin. Unlike most sites, much of the preliminary design has been completed for trial, and therefore work could begin within several months of a final remedy decision.

Question 17. Should the Whiteheads continue to farm?

Response: Results of the Public Health and Environmental Endangerment Assessment (PHEEA) conducted during the groundwater investigation indicate that it is safe for the Whiteheads to farm. The PHEEA evaluated exposure scenarios which assumed dermal contact with affected water and injestion of affected water, beef and milk for various age groups. The results of risks associated with exposure scenarios are summarized in the Second Operable Unit Feasibility Study, which indicate risks below EPA's common acceptability range for risks associated with Superfund clean-ups (1 in 1,000,000 risk). Probable scenarios of future land use were developed for exposure calculations Probable exposure scenarios for a child or adult were a few orders of magnitude below EPA's acceptablilty range, however, worst case scenario results showed risks from exposure to be between 10^{-4} through 10^{-6}.

Question #18. Will appeals be made to the court decision?

Response: We do not know. Certainly all sides in the case have the legal right to do so, but whether or not that right will be exercised will have to be seen after a ruling has been made.

Question #19. Some of the residents near the site have been told they will have to move for the clean-up. What if they do not want to?

Response: It is not and has never been the position of EPA that any of the area residents would have to move. Because of the need to locate some of the portions of the groundwater portion of the clean-up off of what was the original Hardage site, access to some area properties may be needed to implement the clean-up. EPA does not feel that it is necessary to move for the purpose of institutional controls, but cannot rule out the possibility of temporary re-location during remedy construction. If no agreement can be reached on allowing access to property for implementation of the clean up the government could as a last resort obtain such access through the use of emminent domain. However, the need to resort to such a method has been rare.

Question #20. Is there water contamination to the north? My grandfather drilled three wells in an area of North Criner Creek north of the area of contamination shown in the fact sheet.

Response: Data collect for and by EPA does not indicate that contamination has migrated to this area. To be on the safe side, however, the Oklahoma State Department of Health (OSDH) has sampled the wells in question. The has indicated that results were sent to residents, which showed no detectable contamination.

Question #21. Has all of the seismigraphic work in the area fractured the bedrock?

Response: Geologic studies at the site have revealed details regarding the stratigraphy and structure of the site area. While fractures were noted in the local bedrock, there is no reason to believe these have been caused by seismic testing in the area.

Question #22. Are there faults in the area?

Response: Studies reported in the literature have provided evidence for deep, complex faulting in the Criner region. Depths of over 5000 feet are suggested for such complex faulting. No evidence has been found in the literature to suggest that these faults extend up into the younger (less than about 1000 feet deep) bedrock in the vicinity of the site.

Question #23. Something needs to be done quickly to remedy the site problems.

Response: EPA agrees with this statement. Fortunately the upcoming trial is set for November 27, 1989.

Question #24. The reputation of the area has been devastated and property values depressed. These things aren't being addressed. The only way to restore confidence is to remove the drums from the site completely and highly publicize the event.

Response: The selected remedy calls for the removal and destruction of contaminants contained in the source areas through liquid extraction, excavation, and soil vapor extraction. The rapid and permanent destruction of contaminants is one of the primary benefits of the selected remedy over other options that have been proposed or considered.

Question #25. Once remediation of the Hardage/Criner Site is complete and for some unforeseen reason the selected means of remediation does not prove to be sufficient, will the PRP's be financially responsible for an extended remediation?

Response: Responsibility remains even after remediation. Should additional activity beyond that selected in this Record of Decision be needed the same parties would still be liable for remediaiton. Such determinations are made on the basis of the 5 year Superfund review process and though re-openers in consent agreements, which provide for continuing liability if additional work becomes necessary.

Question #26. If material from the site is transported offsite to another disposal facility and this facility later becomes a Superfund site will the PRP's be financially responsible for the material transported to the site from Hardage/Criner?

Response: The generators of the material would still be responsible for it. This scenario is not expected to occur as the materials taken offsite should be destroyed in compliance with EPA regulations.

Question #27. Can the land be put back like it was?

Response: No. The best that can be done is to remove and destroy as much of the contamination as is possible and to reduce the threat posed by what contamination remains by limiting its mobility and by careful maintenance and monitoring of the site. Because of the need to maintain a cap on the site, the land will very likely lay fallow.

Question #28. (OSDH) The objective of Superfund is the protection of public health and the environment. Any release of contamination into the water or air resulting from the remedial action at the site is inappropriate and runs counter to this objective.

Response: The objective of Superfund is the protection of human health and the environment. This objective includes protection from both long-term and short-term risks. The short-term risks posed by excavation of the drums from the source areas exist, but can be controlled as described in the Response to Question #7 for releases to air. The excavation of buried drums is an established technique which has been successful at similar hazardous waste sites. Experience at such sites has shown the precautions which need to be taken to minimize any short-term risks to the site workers or to the public.

The long-term risks associated with the Hardage site are a grave concern. Ultimately this concern can only be minimized by the recovery and destruction of the contaminants. No one can predict what will occur over time as the drums buried in the source areas corrode and continue to release their contamination to escape into the environment. As these wastes mix and migrate the risks they pose will continue. These risks include chronic, long-term risks posed by carcinogenic compounds. With no known time limit for the release of the contamination from the source areas a choice is apparent between rapid removal and destruction of contaminants using pre-planned engineering and safety controls successful in other similar excavtions. The alternative is attempts, with many uncertainties, to achieve long-term containment of hazardous and carcinogenic contaminants which are mobile and subject to continued release into the environment under conditions that are neither known or controlled.

Question #29. (OSDH) The data provided does not support the volume or condition of the drummed waste that was used to justify the removal component of the proposed plan.

Response: It is true that assumptions have been made about how many of the buried drums still contain liquid waste. Faced with the choice of hoping that perhaps all or most of the drums are empty or making the more conservative assumption that they are not, EPA assumes that they continue to pose a threat. Given the stakes, the health of local residents and the environment, we would rather take the precaution of making this assumption and then discover that the drums are empty than gamble that they are empty and later be tragically proven wrong.

Question #30. Can we be confident that all areas relating to soil vapor extraction have been addressed? Can we be confident in the catalytic oxidation process and that this in itself would not contaminate the air?

Response: Once EPA selects the final remedy for the site, a detailed remedy design will be prepared and approved. This design will necessarily address all areas of concern during remediation, including refining the areas of contamination, evaluation in detail the performance of soil vapor extraction, and covering details of health and safety during remedial activities. As far a catalytic oxidation is concerned, EPA is required to utilize the Best Available Control Technology (BACT) for the destruction of contaminated vapors resulting from soil vapor extraction. This is a requirement of the Clean

Air Act and State regulations. If catalytic oxidation does not meet BACT, then an alternate thermal destruction technology will be used. Air monitoring onsite and at site boundaries will be instituted to assure air quality remains below action levels desiged to protect human health.

Question #31. The rural water system should be extended to those concerned about possible domestic groundwater contamination.

Response: There are currently no plans to further extend the rural water system through Superfund. Conditions which would warrent such an extension, such as threatened or impacted groundwater in drainages outside North Criner Creek, do not exist. Questions about potential groundwater contamination from the site have been evaluated and indicates that groundwater plumes are migrating primarily into the alluvium of North Criner Creek where alternate water has been supplied. Planned actions in the alluvium would assure that contamination in the alluvium is geographically controlled and concentrations reduced.

Question #32. A park or recreation area should be set up with information about the site.

Response: EPA has established a repository at the Purcell Public Library which contains all such information.

EPA responses to revisions of the Second Operable Unit reports prepared by ERM-Southwest are found on the following three pages. These revisions were submitted to EPA during the public comment period and are treated since EPA approved the Second Operable Unit RI/FS prior to this time.

TECHNICAL REVIEW COMMENTS
AMENDMENT NO. 1

SECOND OPERABLE UNIT
REMEDIAL INVESTIGATION REPORT
REVISION NO. 1 HARDAGE SUPERFUND SITE
CRINER, OKLAHOMA

The United States Environmental Protection Agency (EPA) conducted a technical review of the Revision No. 1, dated October 10, 1989, to the Second Operable Unit (OU) Remedial Investigation Report (RI) prepared by ERM-Southwest, Inc. Users of the RI should be aware that EPA has a number of comments and technical concerns regarding the report and its Revision No. 1.

Previous EPA review comments were organized to align with the Summary and Conclusions Section (Chapter 6) of the RI report. Individual responses were presented for each of 54 conclusions in Chapter 6. These responses addressed the major areas of concern that EPA has with the RI.

This amendment addresses the October 10, 1989 major revisions to the Summary and Conclusions section (Chapter 6) of the RI report. The revised conclusion is noted and the new response is presented beneath it. Comments could be raised for each of the revised technical sections and subsections of the report.

Users of the RI should therefore consider EPA's broad responses and noted data limitations as needed when reviewing the individual technical sections or appendixes contained within the RI.

Revised Conclusion
Chapter 6--Introductory Paragraphs

EPA disagrees that Stratum II is relatively impermeable; while it may be of lower overall permeability than overlying or underlying units, Stratum II contains fractures and sandstone lenses. The source mounds are also not entirely within the bounds of Stratum II. Excavation of the source mounds into Stratum I sandstones is also suspected.

The presence of drummed solids and liquids in other portions of the Main Pit (besides the west side) is also expected.

Data developed by the HSC expert panel investigation was sponsored by the HSC for their ongoing litigation purposes. This study, as part of litigation, has not been endorsed by EPA.

Revised Conclusion No. 11

EPA does not agree with the characterization of Stratum II as a low permeability unit.

The hydraulic head measurements alone do not yield information on the vertical rate of groundwater movement through Stratum II. Hydraulic conductivity and porosity values are also necessary.

EPA does not agree with ERM's revised groundwater velocities for Stratum I and Stratum III. ERM's values were calculated using median hydraulic conductivity values and the lowest hydraulic gradient observed during the study. Recalculating the velocities using the range of measured hydraulic conductivities and hydraulic gradients reveals that Stratum I velocities could range from 1/2 to 1,000 feet per year and Stratum III velocities could range from 0.003 to 250 feet per year.

Revised Conclusion No. 15

No comment.

Revised Conclusion No. 21

EPA desires to state that the period of record, while revised to include a longer period, is still relatively short and may therefore not be fully representative of the range of flows that may be encountered in the creek.

Revised Conclusion No. 26

The peak flow measured for the south pond may not be relevant since it is controlled by discharge through a pipe rather than site hydrology.

It should be noted that the period of record, while revised to include a longer period, is still relatively short and may therefore not be fully representative of the range of flow from the south pond or the alluvium.

Revised Conclusion No. 43

The modeling performed by SSPA was not conducted as an approved task under the second OU work plan. This modeling is being performed as a result of the HSC litigation effort and will be evaluated separately.

As stated in previous responses, EPA does not agree that the contamination found in the alluvial system is predominantly the result of surfical transport.

Revised Conclusion No. 45

See Revised Conclusion No. 43 response.

Revised Conclusion Nos. 54 and 55

The PHEEA does not address the exposure pathway that led to the provision of an alternative drinking water supply to the residents previously dependent on well water from the North Criner Creek alluvium. The PHEEA also ignores the potential exposure of humans via the ingestion of aquatic organisms, at an annual consumption of about 5 pounds per year, which is possible under a recreational scenario for North Criner Creek. This is very important since the 10^{-6} carcinogencic risk criteria for some volatile organic compounds, (such as 1,1-Dichloroethene at 1.85 ug/l) relative to the consumption of aquatic life, is less than CLP contract detection limits.

The PHEEA also does not address a "no action" alternative that action alternative risk reductions can be compared to.

The range of risks developed in the PHEEA are applicable only to the exposure scenarios evaluated and are lacking in that the ingestion of ground water and/or aquatic life potential exposure scenarios are conspicuously absent.

The PHEEA also does not use reference doses, Rfds, nor does it follow the more recent EPA guidance for the preparation of Human Health Evaluations 9285.701A dated July 1989.

APPENDIX F

1986 RECORD OF DECISION FOR SOURCE CONTROL

RECORD OF DECISION

(ENFORCEMENT DECISION DOCUMENT)

Site

Hardage/Criner located in McClain County, Oklahoma

Documents Reviewed

I am basing my decision on the following documents which describe the cost-effectiveness of source control remedial alternatives for the Hardage/Criner Site:

- Field Investigation and Data Summary Report, Royal Hardage Industrial-Hazardous Waste Site near Criner, Oklahoma, by CH_2M Hill, dated May 1984.
- Source Control Feasibility Study, Royal Hardage Industrial Hazardous Waste Site near Criner, Oklahoma, by CH_2M Hill, dated February 1985.
- Preliminary Public Health Assessment for Groundwater Ingestion for the Hardage/Criner site by CH_2M Hill, dated August 1985.
- Summary of Remedial Alternative Selection, November 1986.
- Data gathered prior to and during enforcement actions in 1982 as described in Appendix A to the Summary of Remedial Alternatives.
- August 1986 memo, Bill Langley to Bob Davis describing review and confirmation of 1984 data from sludge mound sampling.
- Public comments received March 10 - April 15, 1986 on the Source Control Feasibility Study.
- Community Relations Responsiveness Summary, November 1986.
- Staff summaries and recommendations.
- Reference materials for the documents listed above.

Description Of Recommended Final Source Control Remedy

Excavate the principal source areas (drum mound, main pit, and sludge mound) to bedrock and separate wastes for treatment as follows:

- Solids - treatment and disposal in an on-site landfill cell constructed and operated in compliance with the Resource Conservation and Recovery Act of 1976, as amended (RCRA).

- Organic liquids will be incinerated.

- Inorganic liquids will be treated and disposed by other means, as appropriate.

Temporarily close areas of residual contamination at the former source areas until remedial action is selected under the second operable unit.

Decision

Consistent with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the National Oil and Hazardous Substances Contingency Plan (40 CFR Part 300), I select the remedy described above (alternative number seven from the Source Control Feasibility Study) for the Hardage/Criner site. I have determined that this remedy is cost-effective and is protective of public health and welfare and the environment. The action will require operation and maintenance to maintain the effectiveness of the remedy. Since wastes will be left on-site, the remedial action will be reviewed every five years to assure that the remedy is still protecting public health and the environment. The State of Oklahoma has been consulted on the remedy. I have considered Section 121 of the Superfund Amendments and Reauthorization Act of 1986 (SARA), including the cleanup standards thereof, and certify that the portion of the remedial action covered by this Record of Decision (ROD) complies to the maximum extent practicable with Section 121 of CERCLA (as amended by Section 121 of SARA).

If negotiations are successful, potentially responsible parties (PRPs) will enter into a Consent Decree with EPA authorizing the PRPs to implement the remedial action. In the event that negotiations are unsuccessful, on-going litigation will be pursued by EPA and the Department of Justice in an effort to secure performance of the remedial actions.

11/14/86
Date

Frances E. Phillips

Frances E. Phillips
Acting Regional Administrator

HARDAGE/CRINER
RECORD OF DECISION CONCURRENCE

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Office of Regional Counsel

SUMMARY OF REMEDIAL ALTERNATIVES SELECTION
FOR SOURCE CONTROL

HARDAGE/CRINER SUPERFUND SITE
MCCLAIN COUNTY, OKLAHOMA

NOVEMBER 14, 1986

SUMMARY OF REMEDIAL ALTERNATIVE SELECTION
HARDAGE/CRINER
MCCLAIN COUNTY, OKLAHOMA

1.0 Site Location and Description

2.0 Operating History

3.0 Current Site Status

4.0 Risk to Public Health and Welfare and the Environment

5.0 Alternative Development and Screening

6.0 Selected Alternative

7.0 Compliance of Remedial Action with Applicable or Relevant and Appropriate Requirements

8.0 Operation and Maintenance of the Remedy

9.0 Compliance of Source Control Remedy with Section 121 of the Superfund Amendments and Reauthorization Act of 1986 (SARA) to the Maximum Extent Practicable

10.0 Other Operable Units

11.0 Enforcement

12.0 Community Involvement

13.0 References

APPENDICES:

A) Chronology of EPA Site Investigations Prior to 1984

B) List of Potentially Responsible Parties Identified for the Hardage/Criner Site

C) Community Relations Responsiveness Summary on the Source Control Feasibility Study

SUMMARY OF REMEDIAL ALTERNATIVE SELECTION
HARDAGE/CRINER
MCCLAIN COUNTY, OKLAHOMA
NOVEMBER - 1986

1.0) SITE LOCATION AND DESCRIPTION

The Hardage/Criner site is located in McClain County, Oklahoma, roughly 15 miles southwest of Norman, Oklahoma and 1/2 mile east of the community of Criner (Fig. 1). The area is agricultural with land on all sides of the site used for grazing cattle. Oklahoma Highway 24 forms the southern boundary of the site and a gravel road runs along the east side of the site (Fig. 2).

2.0) OPERATING HISTORY

The Royal Hardage Industrial - Hazardous Waste Land Disposal Facility was issued an operating permit by the Oklahoma State Department of Health (OSDH) in September 1972 and commenced construction immediately. Two pits were excavated, the main pit and the south pit. Originally, liquids and sludges from drums and tank trucks were discharged directly to these unlined pits. The methods of liquid disposal were evaporation and infiltration; however, the main pit filled to capacity rapidly. Waste from the pit was transferred to temporary ponds, the "west pond" area, where liquids were slurried with soil, transfered on to the south pit and disposed concurrently with styrene tar and oil recycling residues. The south pit was eventually filled in and waste piled to a height of about 10 feet above grade, forming the "sludge mound". After the first years operation, drums were no longer emptied, but rather piled at the north end of the main pit beginning the "drum mound". The mound was extended southward and built to a height of about thirty feet. In all, roughly 18 to 20 million gallons of waste were disposed at the site during its operation. The sequence of operations has been compiled from OSDH inspection reports and a deposition and hearing testimony of the facility owner/operator. In 1978, the State of Oklahoma filed complaints against the facility for suspected lead poisoning of air around the site. In September 1979, OSDH began proceedings to revoke the facility permit for operating unpermitted pits, failure to seal permeable lenses in the pits, improper closure of pits, failure to retain runoff, and improper storage of wastes. In September 1980, the U.S. Department of Justice (DOJ) filed suit on behalf of the Environmental Protection Agency (EPA) against the facility under Section 7003 of the Resource Conservation and Recovery Act (RCRA). Operations ceased in November 1980 prior to the effective date of RCRA interim status requirements. Royal Hardage then undertook site decontamination and closure efforts which extended into 1982. These efforts consisted of mixing fluids in the pits with soil, excavating visibly contaminated soils from mixing areas and temporary ponds and capping the source areas with a layer of soil. During closure, an effort was made to consolidate wastes in the source areas (sludge mound, main pit, and drum mound).

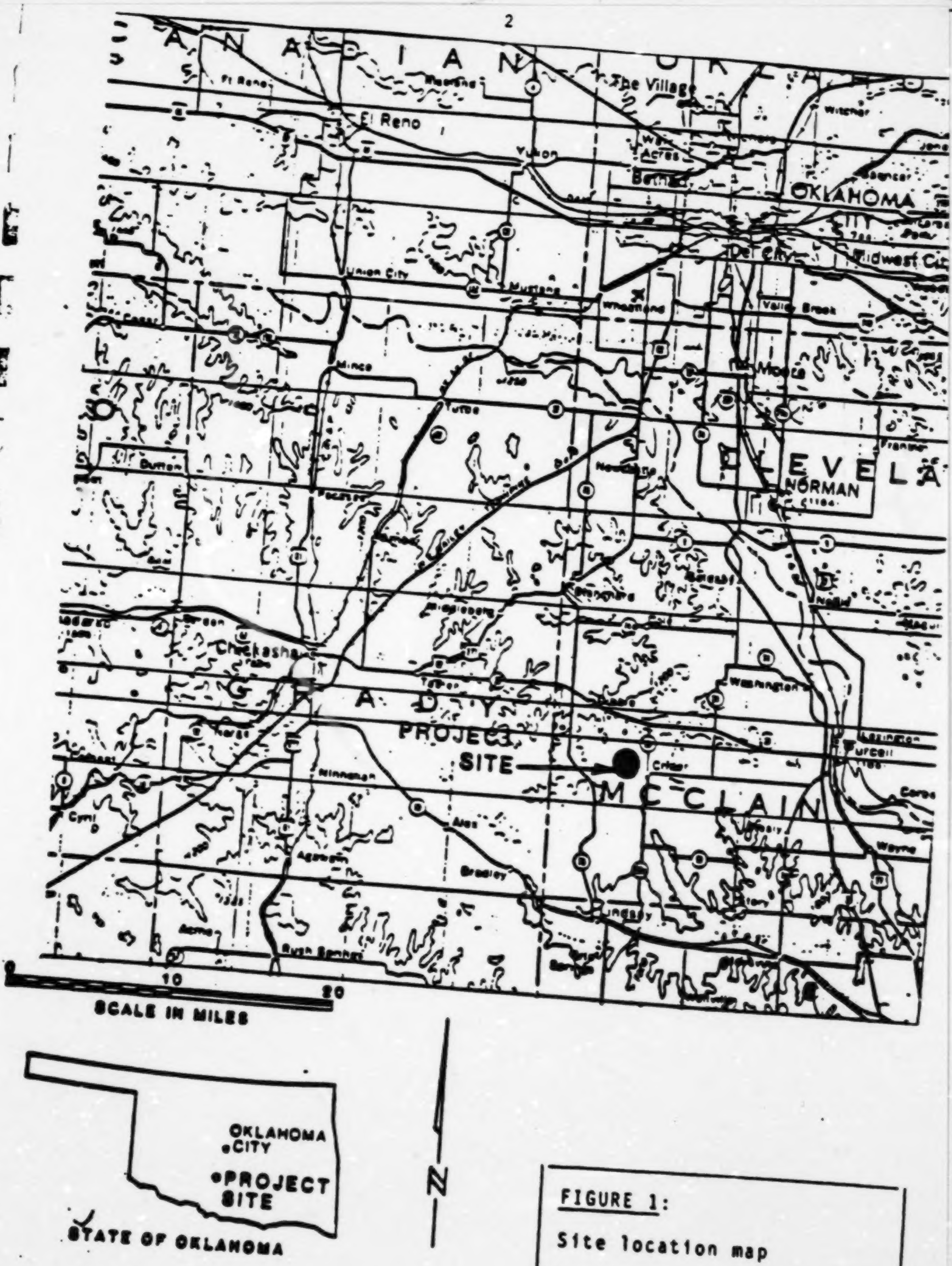
CANADIAN
Ft Reno
The Village
El Reno
Yukon
Bethany
OKLAHOMA CITY
Del City
Midwest City
Union City
Mustang
Wheatland
Valley Brook
Minco
Tuttle
Moore
Newcastle
CLEVELA
NORMAN
Dutton
Pocasset
Blanchard
Chickasha
GRADY
Washington
PROJECT SITE
Criner
McCLAIN
Lexington
Purcell
Ninnekah
Alex
Agawam
Bradley
Lindsay
Cyril
Acme
Rush Springs
0
10
20
SCALE IN MILES
OKLAHOMA CITY
PROJECT SITE
STATE OF OKLAHOMA
N

FIGURE 1:

Site location map

(Hardage/Criner ROD 11/86)

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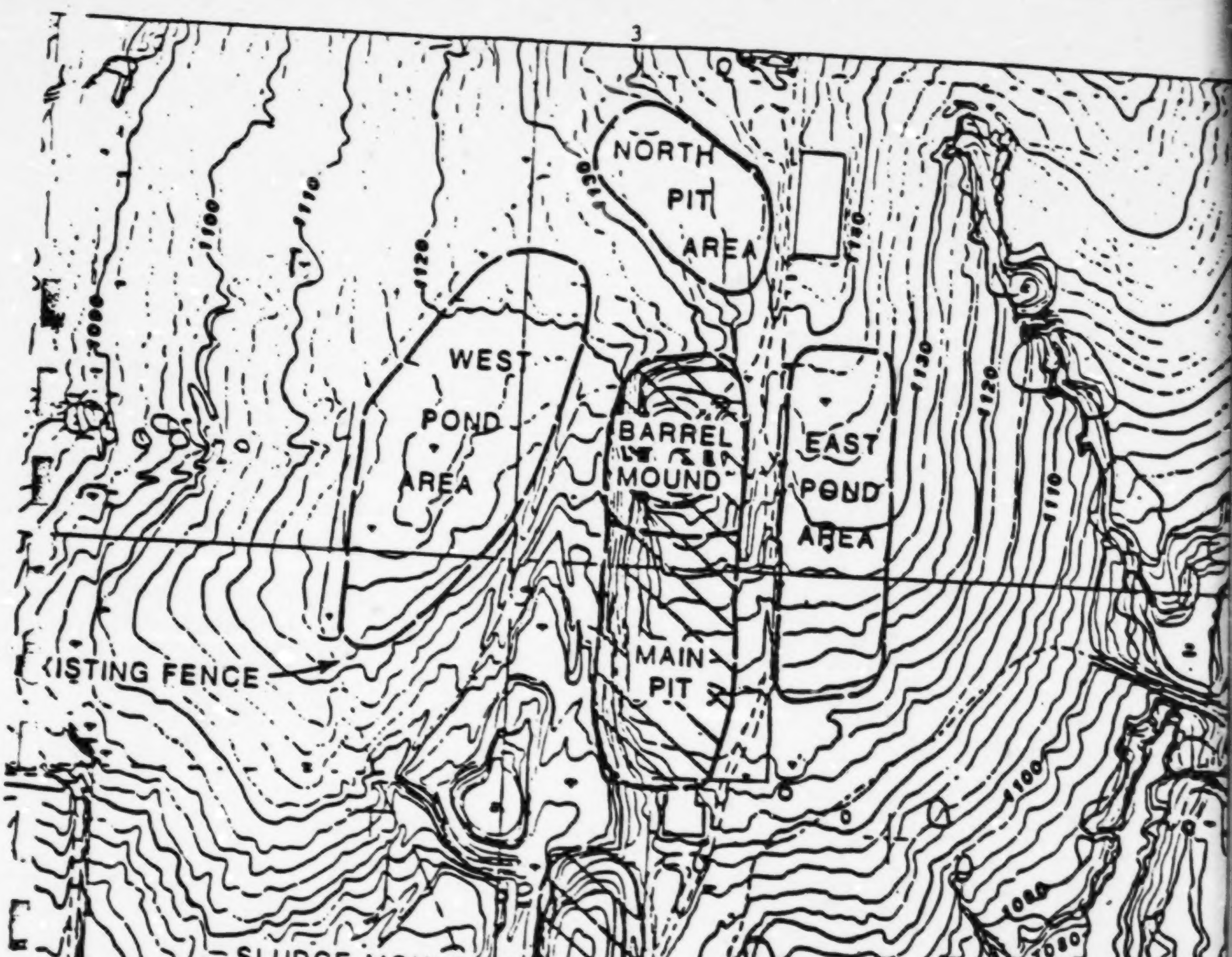

3
NORTH PIT AREA
1130
1100
1110
1120
WEST POND AREA
1090
BARREL MOUND
EAST POND AREA
1130
1120
1110
ISTING FENCE
MAIN PIT
1100
1080
1080
SLUDGE MOUND
1090
INTERCEPTOR TRENCH
1070
1080
1090
1090

north

1" : 300'

FIGURE 2:

Site topographic map

3.0) CURRENT SITE STATUS:

3.1) Site Investigations:

The site was inspected frequently by OSDH during its operation. Inspectors reported widely varying conditions, with problems initially centered around pits filled to capacity and the potential for overflow. In 1976 OSDH requested that Hardage installed groundwater monitoring wells in the southwest drainage. Eventually, thirteen monitoring wells were installed by the operator. These have been periodically sampled ever since, showing uniformly high levels of contamination. Some Hardage wells may have become contaminated by surface runoff entering the well bore during and immediately after construction. However, repeated purging of these wells has not lowered the levels of contaminants.

EPA first inspected the site in July 1979 due to asbestos disposal. EPA contractor Ecology & Environment (FIT) collected samples at the site in August 1979, August and October 1980, and in March and August 1982. In 1984, work was begun by EPA contractor CH_2M Hill to gather supplemental data to allow preparation of a Feasibility Study (FS) for permanent remedial actions on the site. This supplemental data was compiled and field work was documented in a Data Summary Report (DSR) completed in May 1985. A chronology of EPA sampling efforts prior to 1984 is given Appendix in A.

3.2) Contaminants:

The site was permitted to accept all types of industrial and hazardous wastes except radioactive materials (OSDH-1972). A total 18 to 20 million gallons of waste was logged into the site. The resulting mixture contains virtually every type of waste produced by industries operating in the States of Oklahoma and Texas from 1972 through 1980. The general types of waste accepted at the site included: oil recycling wastes, chlorinated solvents, styrene tars, acids, caustics, paint sludges, lead, chromium, cyanide, arsenic, pesticides, inks, PCBs, and large quantities of waste of unknown content from injection wells and other facilities including what became the Brio and Bio Ecology Superfund sites (Hardage 1972-1980, Eltex 1985). Under each of these broad waste types are numerous specific wastes streams produced from perhaps hundreds of different industrial processes, each waste having it's own unique characteristics, impurities, and inherent hazardous and toxic properties.

Some of the contaminants which pose an immediate threat through groundwater are chlorinated solvents, including: 1,2-dichloroethane, 1,1,2-trichloroethane, 1,1-dichloroethene, tetrachloroethene, and trichloroethene (CH_2M Hill 1986a). Other compounds such as lead, chromium, PCB, and toxaphene are present on the site and will pose long term or permanent hazards due to their persistence in the environment. This is by no means an exhaustive list of either the wastes sent to the site or the contaminants of concern; further information is contained in the source control FS.

3.3) Remaining Features:

Source areas include the main pit, drum mound, and sludge mound (Figure 2). The slude mound covers 1.5 acres to a thickness of from 15 to 20 feet above and within the former south pit.

The main pit covers about two acres with a 15 to 20 foot thickness of waste having been slurried with soil and backfilled into the pit, bringing it to the grade of surrounding land on the east and forming a steep berm 10 to 20 feet high on the west. A high concentration of drums is located along the west side of the pit and in the barrel mound which covers about 0.8 acres to a thickness of 30 to 40 feet. Estimates of the number of unemptied drums remaining in the source areas ranges from 10,000 to over 20,000, with knowledge of site operations and history favoring the latter (Hardage 1972-80).

Other areas of the site were used as temporary holding and mixing ponds or may have been incidentally contaminated during site operations. These areas are the west ponds, east ponds, north pit, and the southwest drainage (Figure 2).

Two buildings are still on-site. A former sludge drying building used during the last year of operations is located northeast of the drum mound. A barn, used as the office, is between the sludge mound and main pit.

3.4) Hydrology:

North Criner Creek runs in a northwest to southeast direction south of the site with the alluvial valley extending nearly to the southwest corner of the site. This stream is perennial and joins Criner Creek roughly one mile south of the site. Criner Creek empties into the Washita River thirteen miles south of the site.

A stream runs along the east side of the site, about 400 feet east of the waste areas. This stream has been impounded to form a chain of three small lakes totalling about 6 acres. Another two acre pond lies about 1500 feet west of the drum mound.

3.5) Geology:

The site lies in what are commonly referred to as "redbed" sediments. This is a thick sequence of shales, mudstone, and sandstones which grade back and forth over the space of tens to hundreds of feet. The geology was originally described as consisting of the Bison shale overlying the Purcell sandstone. Site investigations indicated these units are not differentiated at the site; so shallow bedrock is referred to collectively as the Hennesey formation (CH_2M Hill 1985).

Beds generally dip to the south and southwest at less than 5°. No major faults are believed to underlie the site. However, a well defined regional joint system is present with joint sets observed at N 20° W, N 20° E, and N 50° W (Kent 1982).

The alluvium of North Criner Creek is 40 to 60 feet deep at mid valley and made up of decomposed bedrock from adjacent uplands.

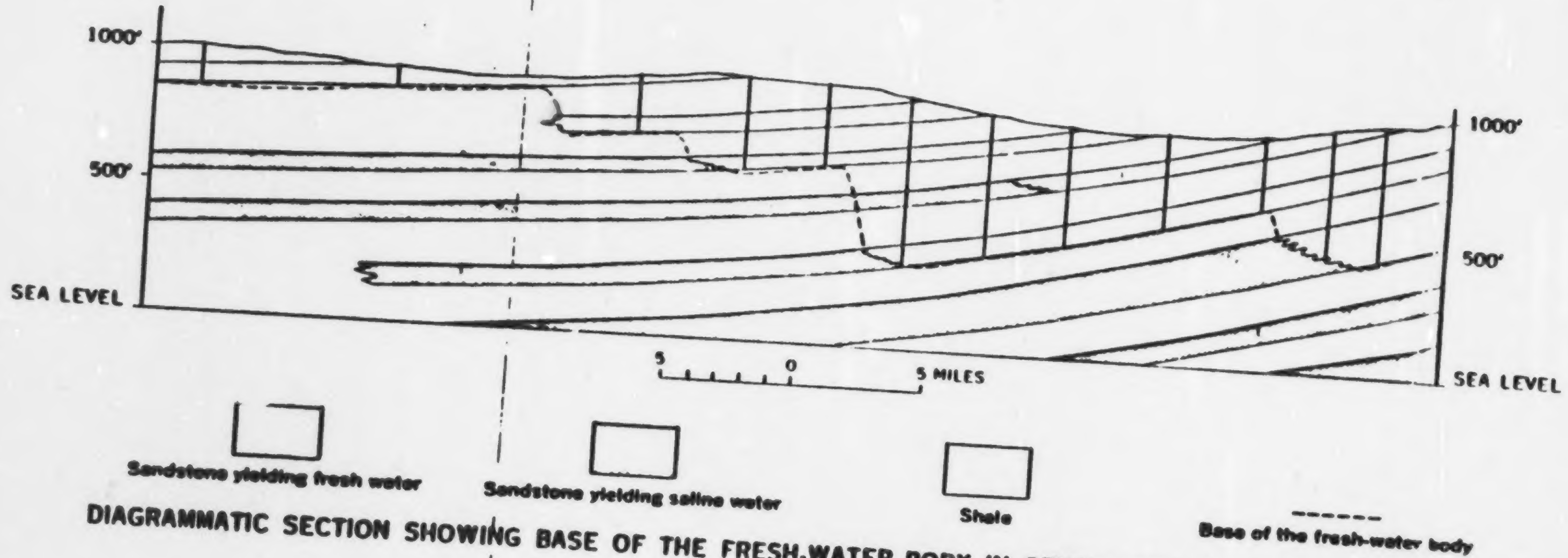
3.6) Geohydrology:

The groundwater table beneath the site generally follows topography and flows are to the southwest and east. Adjacent monitoring wells completed at different depths strongly indicate a vertical (downward) flow component exists. Shales and mudstones underlying the site are fractured and provide a secondary permeability which, coupled with horizontal sandstone beds, has allowed migration of leachate from 400 to as much 2000 feet laterally through the bedrock and over 50 feet beneath the bedrock surface. Questions exist on the method of transport to the southwest, where waste has migrated over 2000 feet by unconfirmed pathways to enter the alluvium of North Criner Creek and apparently form a plume over 1000 feet long in the alluvial aquifer. Further evidence of the bedrock's inadequacy as a barrier to migration is provided by consideration of contamination in two of the CH_2M Hill - 1984 wells (BW-4, GTW-3) and in a series of four FIT - 1982 wells (EW-3,EW-5,EW-6, and EW-7) located to the east and southeast of the sludge mound. These wells are in areas where no site operations occurred and where runoff would not be channeled by topography. The observed 400 feet of migration into these wells over the twelve years between 1984 and 1972 indicates a rate of transport greater than 33 feet per year.

3.7) Areal Groundwater Supplies:

Where possible, residents of the area have drilled water supply wells into the shallow alluvium of streams such as North Criner Creek. However, farms not located in alluvial valleys and without access to these supplies can and have drilled producing wells into the Hennesey formation within one mile of the site. Although not formally classified, both the Criner and North Criner Creek alluvial aquifers and the Hennesey formation would generally be categorized as Class IIb under the EPA Groundwater Protection Strategy.

Fresh water in this area is generally contained in the upper sediments, with water becoming progressively more salty or brackish with depth as indicated in Figure 3 (USGS -1966).


1000'
500'
SEA LEVEL
1000'
500'
SEA LEVEL
5
0
5 MILES
Sandstone yielding fresh water
Sandstone yielding saline water
Shale
Base of the fresh-water body

DIAGRAMMATIC SECTION SHOWING BASE OF THE FRESH-WATER BODY IN GENTLY DIPPING SANDSTONE BEDS

FIGURE 3:

Regional hydrogeology
(USGS - 1966)

3.8) Extent of Contamination:

Groundwater has been contaminated beneath and adjacent to the source areas, in the southwestern drainage, and to the east and southeast of the source areas to depths greater than 50 feet. The alluvium of North Criner Creek has been contaminated, as evidenced by the presence of from 100 to 300 ppb of volatile organic chemicals in three separate wells, which indicates a plume over 1000 feet long (Figure 4). The relative contribution of surface and subsurface pathways to alluvial contamination is unknown. However, transport rates observed on other parts of the site indicate the source areas will, over time, continue or begin to introduce contaminants to the alluvial aquifer through surface and subsurface migration routes.

Soils may be contaminated over several tens of acres as a result of indiscriminant operations and closure. Evidence of this is provided by both visible surface contamination and stressed vegatation. Determination of the extent of surface contamination will require a significant sampling effort during the second unit RI to adequately define the areas requiring remedial measures.

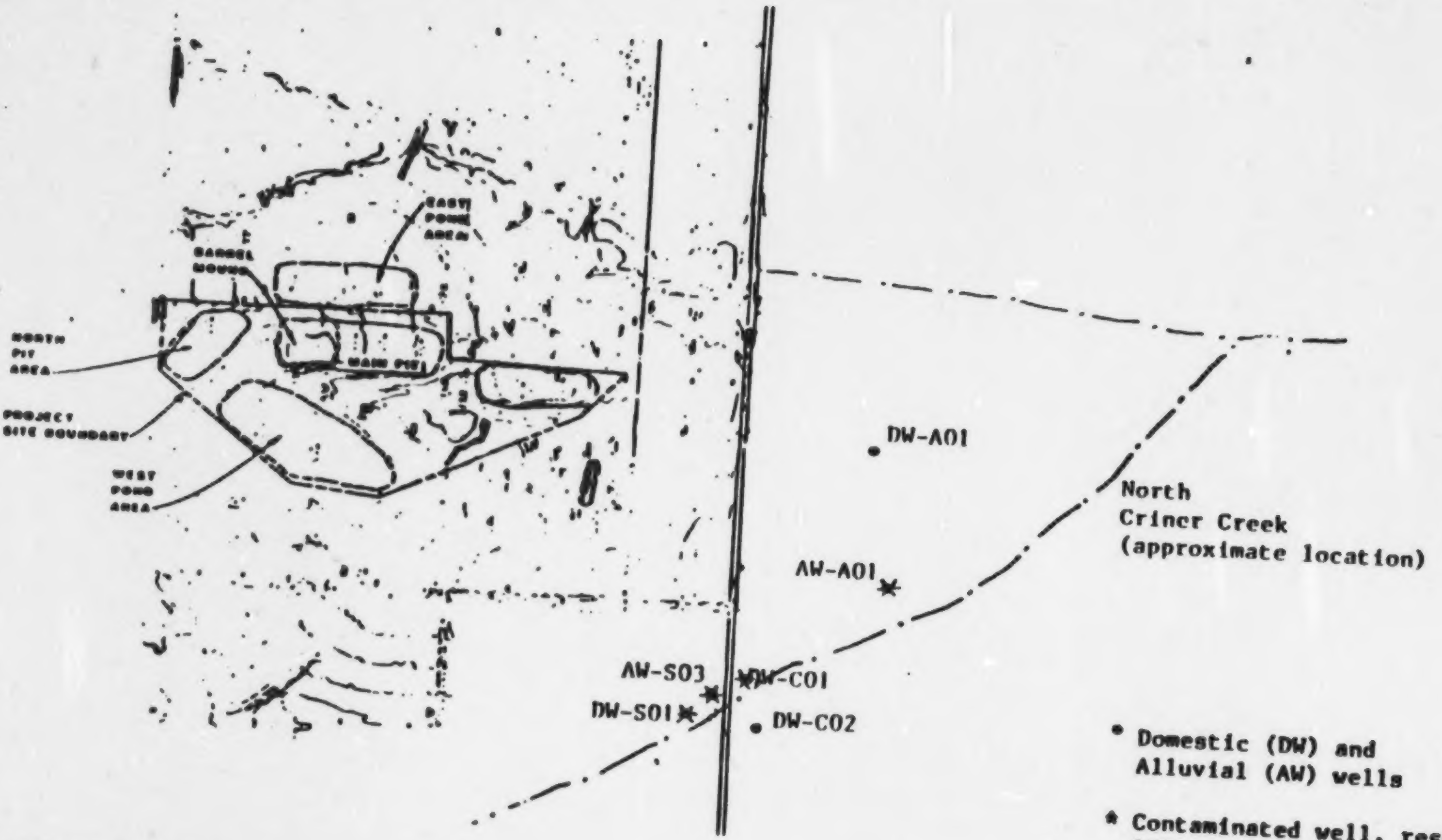
4.0) RISK TO PUBLIC HEALTH AND WELFARE AND THE ENVIRONMENT

Many of the compounds present at the Hardage site are either known or suspected carcinogens. Other compounds either are or are believed to be acutely toxic or capable of causing damage to specific organs. Some of these compounds also bio-accumulate in plant, animal, and human tissues.

The principal routes of exposure for humans are: Groundwater ingestion, direct contact, ingestion resulting from contamination of the food chain and possibly exposure to airborne contaminants.

The alluvial aquifer of North Criner Creek represents the most readily available source of drinking water in the vicinity of the site. This aquifer is contaminated with varying amounts of several chlorinated solvents, as evidenced by sampling of water from the abandoned Corley well and three alluvial monitoring wells. Since several of the compounds detected in these samples are either known or suspected of inducing cancer and/or damage to specific organs of the body, chronic consumption of this groundwater would pose unacceptable health risks.

The Smith and Atkinson/Bearden wells are located 200 and 700 feet respectively from contaminated monitoring wells. Domestic use of water from the abandoned Corley well or the EPA monitoring well AW-S03 would pose lifetime cancer risks in excess of 10^{-4}. Use of groundwater from on-site would pose an excess lifetime cancer risk averaging 2% and up to 60% (CH_2M Hill, 1986a).


NORTH PIT AREA
PROJECT SITE BOUNDARY
WEST POND AREA
BARREL MOUND
EAST POND AREA
MAIN PIT
DW-A01
AW-A01
AW-S03
DW-C01
DW-S01
DW-C02
North
Criner Creek
(approximate location)

- Domestic (DW) and Alluvial (AW) wells

* Contaminated well, results from 1984 sampling shown

0' 500' 1000'

1 inch: 800 feet

VOLATILE ORGANICS (ppb)	C01	A01	S03	S01
1,1-dichloroethane	29	14	20	ND
1,1- dichloroethene	120	82	60	14
tetrachloroethene	6.6	5.5	<4	ND
1,2-trans-dichloroethene	79	<	41	ND
trichloroethene	9.2	ND	<3	ND
1,1,1-trichloroethane	63	6.1	30	<
1,1,2-trichloroethane	11	<	5	ND

< less than detection limit
ND not detected

FIGURE 4:

Contamination observed in off-site alluvial aquifer of North Criner Creek

(Hardage/Criner ROD 11/86)

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Direct contact with wastes on the surface of the site also poses hazards; however, the health risk has not been quantified. Determination of acceptable levels of surface contamination will be a primary concern in the second unit FS. Current human traffic on the site is minimal; but cattle do occasionally graze on the site. Contamination of the food-chain by lead, chromium, pesticides, and PCBs, on the surface of the site poses long-term hazards. This concern has prompted construction of a fence to keep cattle off of the source areas; however, there is evidence of continued intrusion by cattle, giving rise to concerns of food chain contamination. Certain compounds such as pesticides and PCBs have the ability to bioconcentrate through successively higher levels of the food chain (EPA 1985a).

Inhalation of volatiles and contaminated airborne particulates on and possibly adjacent to the site may also pose long term hazards; however, this has not been confirmed.

5.0) ALTERNATIVE DEVELOPMENT AND SCREENING

In accordance with Section 300.68(f) of the NCP and EPA guidance documents (EPA 1985b), several alternatives were developed for source control remedial actions at the Hardage/Criner site. Scoping of general alternatives and objectives for remedial action was first discussed in a 1983 meeting between EPA, OSDH, and EPA contractors. After reconsidering these objectives and alternatives in light of the decision to proceed with a source control operable unit, eleven alternatives were developed (Table 1), as documented in the FS. Of these alternatives, four were retained after screening and developed in further detail (see Section 5.2-5.5 below). Estimated cost ranges for the four alternatives retained are shown in Figure 5.

5.1) Alternatives eliminated in screening:

The most notable result of alternative screening was the elimination of those plans for containing the wastes in place. Several methods of isolating the wastes and reducing or eliminating their release were considered. After screening of technologies, several in-situ containment plans were developed. Of these, capping in conjunction with vertical trenches to intercept shallow groundwater (Alternative #5) would be expected to be the most effective. While this plan may be the most effective in-situ containment plan, it can by no means be considered as an adequate remedy on that basis alone. Consideration of this alternative did, however, serve as a test of whether or not any form of capping-in-place remedy would sufficiently contain the source areas. Technologies such as slurry walls and groundwater injection/withdrawl were eliminated due to the presence of fractured bedrock, observed vertical migration of contaminants, and the absence of any continuous horizontal bedrock layer at

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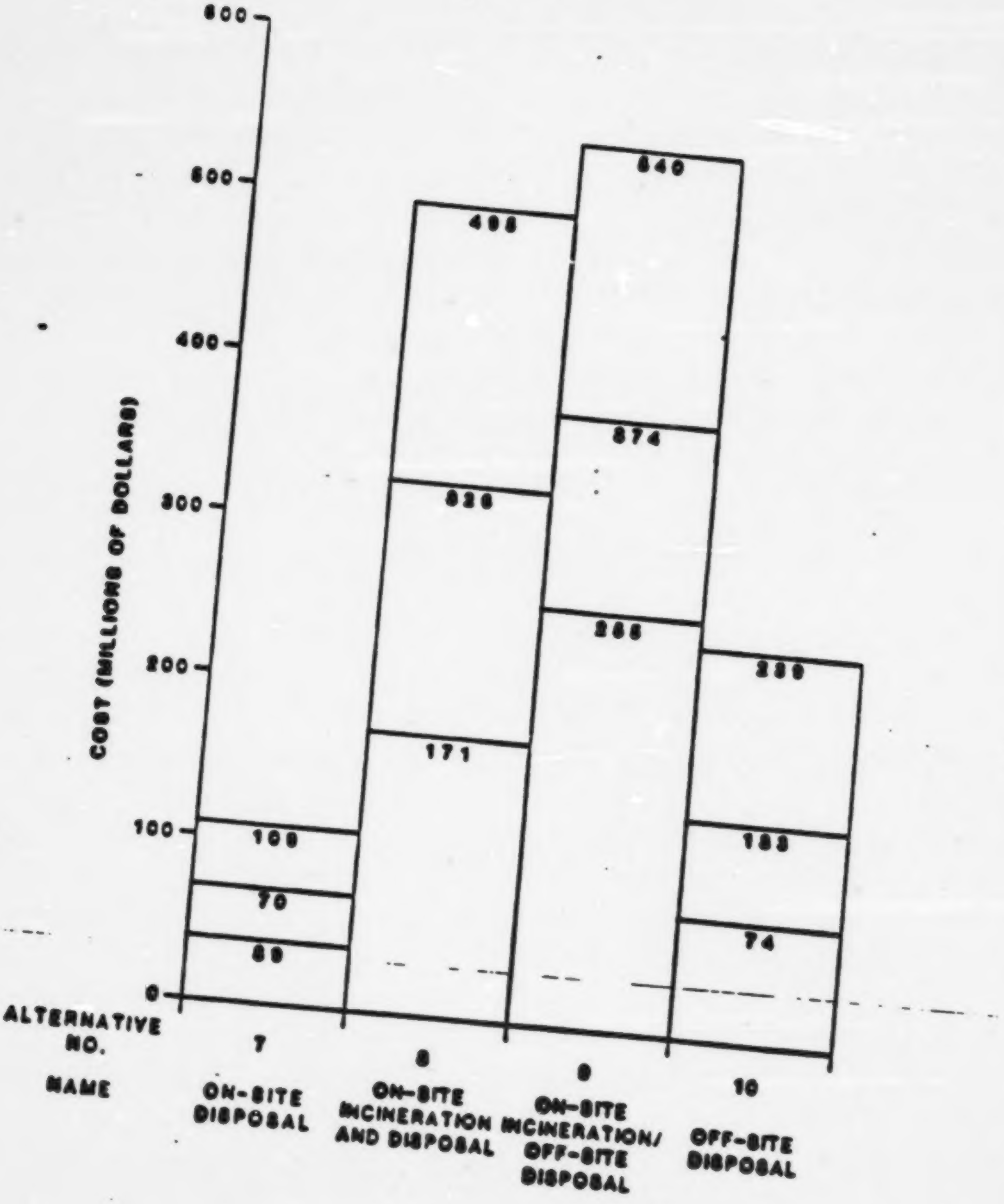
TABLE 1 - Source Control Remedial Alternatives

- **Alternative No. 1 - No Action: no site remedial action taken.**
- **Alternative No. 2 - Limited Action: remedial action consists of grading, revegetation, fencing and institutional restrictions for the site.**
- **Alternative No. 3 - Capping: both source areas would be left in place and covered with a multi-layered cap.**
- **Alternative No. 4 - Upgradient Drains: the source areas would be left in place, covered with a multi-layer cap and upgradient groundwater drains constructed.**
- **Alternative No. 5 - Perimeter Drains: source areas would be left in place, covered with a multi-layer cap and upgradient and downgradient groundwater drains constructed.**
- **Alternative No. 6 - Partial Removal: a cap and perimeter drains would be constructed around the sludge mound, the main pit and barrel mound would be excavated, the wastes treated, as needed, and disposed of in an on-site compliant RCRA landfill.**
- **Alternative No. 7 - On-site Disposal: both source areas would be excavated, the wastes treated, as needed, and disposed of in an on-site RCRA compliant landfill.**
- **Alternative No. 8 - On-site Incineration and Disposal: both source areas would be excavated, the wastes incinerated on-site and disposed of in an on-site RCRA compliant landfill.**
- **Alternative No. 9 - On-site Incineration/Off-site Disposal: source areas would be excavated, the wastes incinerated on site and disposed of in an off-site RCRA compliant landfill.**
- **Alternative No. 10 - Off-site Disposal: both source areas would be excavated, the wastes treated on-site to meet landfill criteria and transported to an off-site RCRA compliant landfill.**
- **Alternative No. 11 - Off-site Incineration: both source areas would be excavated and the majority of the wastes transported to an off-site incinerator for incineration and disposal.**

* Off-site incineration was assumed in some cases for cost-estimating purposes. This does not reflect a final decision to use off-site disposal facilities for any waste from the Hardage site.



UPPER NUMBER REPRESENTS UPPER-BOUND CONDITION,
MIDDLE NUMBER REPRESENTS BASE CONDITION,
LOWER NUMBER REPRESENTS LOWER-BOUND CONDITION.

FIGURE 5: AR0001865

Costs and sensitivity ranges for source control remedial alternatives

(Hardage/Criner

reasonable depth with sufficient integrity to provide a natural base to any engineered containment system. Further discussion of these capping-in-place or in-situ containment technologies and the rationale for their rejection is presented in both the Source Control FS and the Responsiveness Summary (Appendix C).

Consideration of the cap and drain alternative revealed the presence of the same flaws as existed in other plans for containing wastes. The drains were first considered to a depth of five feet below the present groundwater surface. However, migration has been observed to over thirty feet below the water table, indicating that interception substantially deeper than five feet would be necessary to provide meaningful reductions in the releases now occuring. In addition, free liquids present in the landfill and in drums which will continue to deteriorate and burst would be released and allowed to migrate vertically until the source was exhausted. The plan involving shallow (five foot) trenches was estimated to cost $35-40 million. Extensive and continous operation and maintanence (O & M) for the indefinite future would be necessary to maintain the collection system. It was estimated that for collection rates greater than 0.5 gallons per minute, economics would indicate construction of an on-site treatment plant. The problems associated with operating such a system for the indefinite future, meeting discharge requirements and handling occasional peak flows could be significant. In addition, there is no method for assuring the longterm operation of such a treatment system.

The continued release of hazardous wastes and hazardous substances with only negligible lateral interception and no vertical interception, the need for indefinite O & M when such cannot be assured, the potential for continued off-site impacts, and the entire "band-aid" type of approach that this, the most viable in-situ containment alternative entails is wholly inadequate to meet the objective of CERCLA and the directive of the NCP to provide a permanent remedy meeting or exceeding applicable or relevant and appropriate Federal public health and environmental requiremnts. As a result, closure in place was rejected as being incapable of containing wastes in the immediate vicinity of the site and unacceptable as a permanent source control remedy.

5.2) Alternative 7 - On Site Disposal:

The source areas (drum mound, main pit, and sludge mound) would be excavated. Solids would be treated and disposed in a landfill cell constructed on-site. Liquids would generally be incinerated. After completion, the landfill would be closed with a multi-layer cap and gas venting system. The Remedial Action (RA) would require about 18 months to complete at a present worth cost of $70 million (Table 2).

TABLE 2:

ALTERNATIVE NO. 7--ON-SITE DISPOSAL

ITEM	COST
GENERAL	
EXCAVATION, SEPARATION, SAMPLING	$ 1,800,000
TREAT AND TRANSPORT DRUMMED WASTES	$12,979,000
ON-SITE DISPOSAL	$ 5,450,000
SITE RESTORATION	$12,789,000
EVAPORATION/COLLECTION POND FOR SURFACE WATER	$ 196,000
SURFACE WATER TRANSPORTATION, TREATMENT AND DISPOSAL	$ 280,000
OTHER PROVISIONS	$ 5,403,000
Construction Subtotal	$ 249,000
Bid Contingencies (15%)	$39,146,000
Scope Contingencies (20%)	$ 5,872,000
Construction Total	$ 7,829,000
Permitting and Legal (7%)	$52,847,000
Services During Construction (10%)	$ 3,699,000
Total Implementation Costs	$ 5,285,000
Engineering Design Costs (10%)	$61,831,000
TOTAL CAPITAL COSTS	$ 6,183,000
OPERATION AND MAINTENANCE	$68,014,000
(Present Worth)	$ 1,690,000
Bid Contingencies for Operation and Maintenance (15%)	
Scope Contingencies for Operation and Maintenance (20%)	$ 254,000
TOTAL OPERATION AND MAINTENANCE (PRESENT WORTH)	$ 338,000
TOTAL PRESENT WORTH	$ 2,282,000
	$70,296,000

* Off-site incineration was assumed for cost-estimating purposes. This does not reflect a final decision to use off-site disposal facilities for any waste from the Hardage site.

5.3) Alternative 8 - On Site Incineration and Disposal:

The source areas would be excavated. Wastes would be incinerated in a kiln constructed on-site. Ash would still contain metals and, until proven otherwise through de-listing, would require disposal as a hazardous waste. Disposal would be in a landfill cell constructed on-site. This alternative would require four to eight years to implement at an estimated present worth cost of $326 million (Table 3).

5.4) Alternative 9 - On Site Incineration and Off Site Disposal:

The source areas would be excavated and wastes incinerated as above. The difference between this and Alternative 8 would be the off-site disposal of incinerator ash. This alternative would require four to eight years to implement at a cost of $374 million (Table 4). Future O & M for this source control remedy would be non-existent.

5.5) Alternative 10 - Off Site Disposal:

The source areas would be excavated; and wastes would be transported off-site to existing Treatment Storage and Disposal (TSD) facilities for landfilling, incineration, reuse/recycling, or other treatment as appropriate. This alternative could be implemented in about 2 years at an estimated present worth cost of $133 million (Table 5). As with alternative 9, O & M would be non-existent.

6.0) SELECTED ALTERNATIVE:

Alternative 7 (On-Site Disposal) is selected as the appropriate remedy for source control at the Hardage/Criner site. The process by which this alternative was chosen over the other three under consideration is outlined below.

6.1) Remedial alternative selection procedure:

EPA is required by Section 300.68(i) of the NCP to determine the appropriate extent of remedy by, "Selection of a cost-effective remedial alternative that effectively mitigates and minimizes threats to and provides adequate protection of public health and welfare and the environment". The NCP goes on to state that the selected remedy will attain or exceed applicable or relevant and appropriate Federal environmental and public health requirements. EPA has considered the cost, technology, reliability, administrative and other concerns in selecting Alternative 7 as the appropriate remedy, as documented below. These considerations have only been applied to alternatives meeting or exceeding the above noted requirements.

TABLE 3:

ALTERNATIVE NO. 8--ON-SITE INCINERATION AND DISPOSAL

ITEM	COST
GENERAL	
EXCAVATION, SEPARATION, SAMPLING	$ 7,352,000
ON-SITE INCINERATION OF WASTE FILL	$ 12,979,000
TREAT AND TRANSPORT DRUMMED WASTES	$130,500,000
ON-SITE DISPOSAL	$ 2,916,000
SITE RESTORATION	$ 10,175,000
EVAPORATION/COLLECTION POND FOR SURFACE WATER	$ 196,000
SURFACE WATER TRANSPORTATION, TREATMENT AND DISPOSAL	$ 310,000
OTHER PROVISIONS	$ 21,611,000
Construction Subtotal	$ 249,000
Bid Contingencies (15%)	$186,288,000
Scope Contingencies (20%)	$ 27,943,000
Construction Total	$ 37,258,000
Permitting and Legal (7%)	$251,489,000
Services During Construction (10%)	$ 17,604,000
Total Implementation Costs	$ 25,149,000
Engineering Design Costs (10%)	$294,242,000
TOTAL CAPITAL COSTS	$ 29,424,000
	$323,666,000
OPERATION AND MAINTENANCE (Present Worth)	$ 1,384,000
Bid Contingencies for Operation and Maintenance (15%)	$ 208,000
Scope Contingencies for Operation and Maintenance (20%)	$ 277,000
TOTAL OPERATION AND MAINTENANCE COSTS (PRESENT WORTH)	$ 1,869,000
TOTAL PRESENT WORTH	$325,535,000

* Off-site incineration was assumed for cost-estimating purposes. This does not reflect a final decision to use off-site disposal facilities for any waste from the ardage site.

TABLE 4:

ALTERNATIVE NO. 9--ON-SITE INCINERATION/OFF-SITE DISPO

ITEM	COST
GENERAL	$ 7,928,000
EXCAVATION, SEPARATION, SAMPLING	$ 12,979,000
ON-SITE INCINERATION OF WASTE FILL-- Design, Construction and Operation	$130,500,000
TREAT AND TRANSPORT DRUMMED WASTES	$ 3,788,000
WASTE FILL REMOVAL TO OFF-SITE LANDFILL	$ 16,958,000
OFF-SITE LANDFILL DISPOSAL CHARGES	$ 20,850,000
SITE RESTORATION	$ 196,000
EVAPORATION/COLLECTION POND FOR SURFACE WATER	$ 310,000
SURFACE WATER TRANSPORTATION, TREATMENT AND DISPOSAL	$ 21,611,000
Construction Subtotal	$215,120,000
Bid Contingencies (15%)	$ 32,268,000
Scope Contingencies (20%)	$ 43,024,000
Construction Total	$290,412,000
Permitting and Legal (7%)	$ 20,329,000
Services During Construction (10%)	$ 29,041,000
Total Implementation Costs	$339,782,000
Engineering Design Costs (10%)	$ 33,978,000
TOTAL CAPITAL COSTS	$373,760,000
OPERATION AND MAINTENANCE (Present Worth)	$0
Bid Contingencies for Operation and Maintenance (15%)	$0
Scope Contingencies for Operation and Maintenance (20%)	$0
TOTAL OPERATION AND MAINTENANCE COSTS (PRESENT WORTH)	$0
TOTAL PRESENT WORTH	$373,760,000

TABLE 5:

ALTERNATIVE NO. 10--OFF-SITE DISPOSAL

ITEM	COST
GENERAL	$ 2,538,000
EXCAVATION, SEPARATION, SAMPLING	$ 12,979,000
TREAT AND TRANSPORT DRUMMED WASTES	$ 7,584,000
WASTE FILL REMOVAL TO OFF-SITE LANDFILL	$ 21,228,000
OFF-SITE LANDFILL DISPOSAL CHARGES	$ 26,100,000
SITE RESTORATION	$ 196,000
EVAPORATION/COLLECTION POND FOR SURFACE WATER	$ 280,000
SURFACE WATER TRANSPORTATION, TREATMENT AND DISPOSAL	$ 5,403,000
Construction Subtotal	$ 76,308,000
Bid Contingencies (15%)	$ 11,446,000
Scope Contingencies (20%)	$ 15,262,000
Construction Total	$103,016,000
Permitting and Legal (7%)	$ 7,211,000
Services During Construction (10%)	$ 10,302,000
Total Implementation Costs	$120,529,000
Engineering Design Costs (10%)	$ 12,053,000
TOTAL CAPITAL COSTS	$132,582,000
OPERATION AND MAINTENANCE (Present Worth)	$0
Bid Contingencies for Operation and Maintenance (15%)	$0
Scope Contingencies for Operation and Maintenance (20%)	$0
TOTAL OPERATION AND MAINTENANCE COSTS (PRESENT WORTH)	$0
TOTAL PRESENT WORTH	$132,582,000

6.1.1) Comparison of on-site versus off-site remedial action alternatives:

Two alternatives, 7 and 8, involve on-site disposal of wastes excavated from source areas. Alternatives 9 and 10 entail complete off-site disposal of wastes. The alternatives 7 and 10 involve essentially the same operations (i.e. excavation with limited incineration and landfilling for the bulk of wastes), except that they are on and off-site variations of basically the same alternative. Similarly, alternatives 8 and 9 are basically on and off-site disposal options for residue from the on-site incinerator. Based on this point, the analysis below compares on-site to off-site disposal.

Cost: The cost of off-site landfilling and incineration alternatives exceed their on-site counterparts by 90% ($63 million) and 15% ($48 million) respectively.

Technology: The on and off-site options will be virtually identical in the treatment and disposal technologies employed. Control of the quality of work done under the on-site alternatives may be somewhat superior in this respect however, since these actions would be conducted under EPA oversight and off-site treatment or disposal would not.

Reliability: The off-site disposal options will provide reliability in preventing releases from this site, simply because wastes would not remain on-site. However, off-site disposal has the potential to increase health risks at other sites. It is not certain that any significant advantage exists in reliability of off-site over on-site disposal locations. The Hardage/Criner facility is in compliance with the siting requirements currently governing location of commercial disposal facilities. For this reason, any particular vulnerabilities which are present on the Hardage site would not necessarily be absent at off-site facilities.

Administrative: Each alternative will comply with RCRA Part 264 requirements, long-term objectives of CERCLA as amended, and all applicable or relevant and appropriate requirements for protection of public health and welfare and the environment. Since wastes will be left on-site, the remedial action will be reviewed every five years after it's completion, as required by the Superfund Amendments and Reauthorization Act of 1986 (SARA), to assure that the remedy is still protecting public health and the environment.

Other concerns: (Safety during implementation) Both on and off-site alternatives carry inherent risks during excavation. As discussed later, these impacts can be controlled. The primary difference between the on and off-site alternatives with respect to safety during implementation is the potential for accidents or spills during off-site transport of the wastes. For example, an estimated 11,000 loads would be required to transport the entire 180,000 cubic yards of waste off-site. For the 400 to 800 mile transport distance assumed in the FS, trucks carrying waste from the Hardage site would be on the road from four to eight million miles.

Consideration of the components of the four remedial action alternatives evaluated shows that the key difference is the presence of an on-site landfill under the two on-site alternatives. Information collected to date indicates that an adequate landfill cell could be constructed on-site and successfully maintained. The site meets RCRA Section 264.18 siting requirements for seismic stability and flooding potential. Due to the hazards and costs arising from off-site disposal and transport, clear and significant benefits should be present before off-site disposal is selected. Those benefits are not significant or certain in this case. While such benefits may exist in the off-site treatment of small to moderate quantities of specific wastes, organic liquids may be an example, off-site disposal for the entire waste quantity is not preferred over on-site management of wastes in this case. Therefore, the off-site alternatives are eliminated from consideration, and the on-site disposal alternatives (7 - On-site disposal; 8 - On-site incineration and disposal) will be carried on for further evaluation.

6.1.2) Comparison of the two on-site alternatives:

Cost: Alternative 7 would cost $39-109 million to implement, with the most likely cost being $70 million. Alternative 8 would cost $171-495 million, the likely figure being $326 million. Therefore, the benefits to be derived from incineration of all waste would come at a cost of 470% ($256 million) greater than landfilling.

Technology: Incineration is a key component of both alternatives 7 and 8. Since some wastes are liquids which cannot be landfilled, the decision to incinerate organic liquids is appropriate.

Incineration of all wastes will have the net benefit of destroying virtually all organic materials. Even with incineration however, heavy metals will still be present in the residue. These materials simply cannot be destroyed. The mobility can be reduced by treating the waste to reduce it's acidity; this would be done under either alternative.

Reliability: By incineration, virtually all organics are destroyed, leaving an ash with varying contents of heavy metals requiring stabilization and disposal as a "characteristic" hazardous waste. The landfilling alternative, with limited incineration, removes only the free organic liquids with the greatest potential for penetrating a landfill liner and moving into the environment.

Landfilling and incineration of liquids are established technologies, with a demonstrated ability to perform under similar conditions. Incineration of soils contaminated by a heterogenous mixture of wastes, while feasible, has not yet been attempted on a scale such as would be required for complete incineration at the Hardage site.

Administrative: Both alternatives would meet all aplicable or relevant and appropriate requirements for protection of public health and welfare and the environment. Since wastes would be left on-site, the remedial actions would have to be reviewed every five years as required under Section 121 of SARA.

Other concerns: (time to implement) Landfilling can be accomplished in 12 to 18 months. Incineration will take four to eight years.

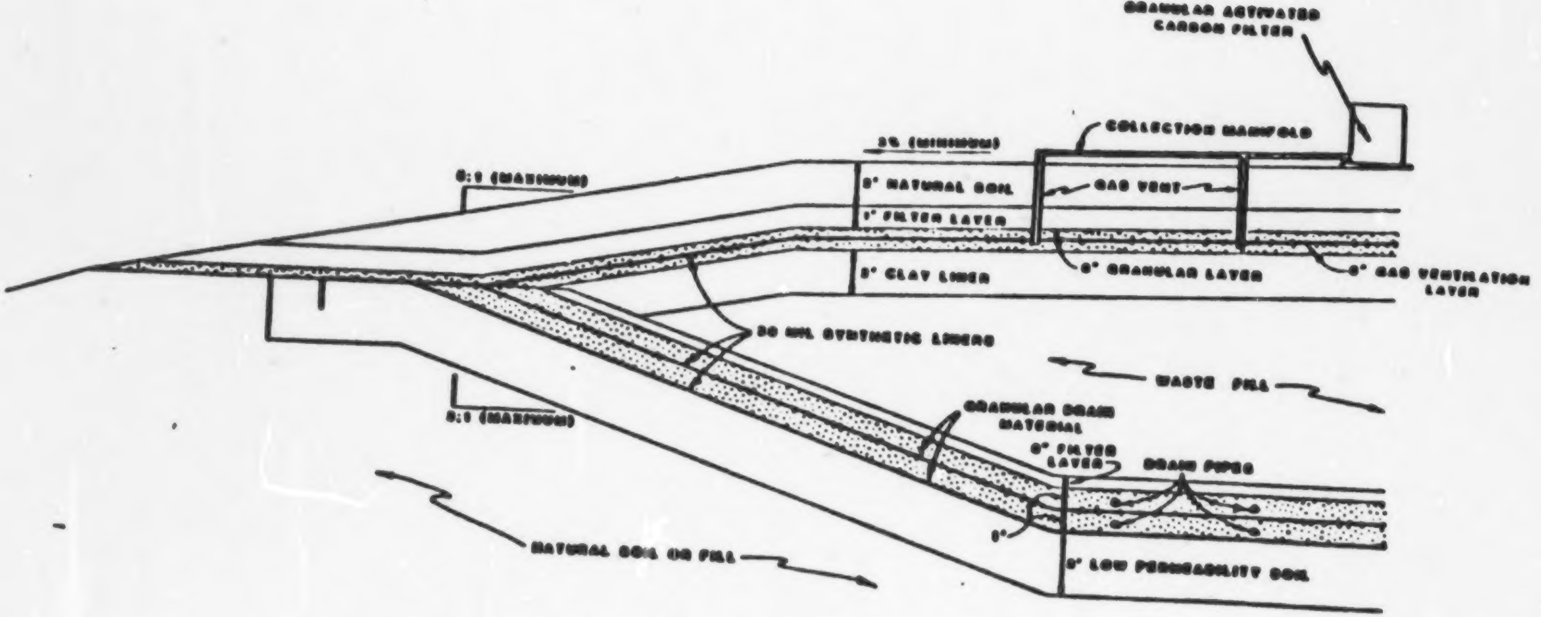
Based on the factors considered above, Alternative 7 (On-site landfill with liquids incineration) is selected as the appropriate remedy for the Hardage/Criner site. This alternative will provide a degree of protection to public health and welfare and the environment similar to that which could be achieved with complete incineration. This remedy can also be carried out in a shorter time using proven technologies which are currently in wide-spread application.

6.2) Detailed Description of the Recommended Alternative:

The following is a general sequence of operations and construction activities required to implement on-site disposal for a source control remedy at the Hardage/Criner site. The timing and specifications will be developed in detail during the Remedial Design (RD) phase of response.

A landfill cell will be constructed to meet the minimum technology requirements for hazardous waste landfills as set forth in RCRA Section 264.301. The key feature of such a landfill cell is a double liner system with interior leachate monitoring and collection (Figure 6). The landfill will be constructed above grade on the high ground west and north of the present source areas, as indicated in the FS. If at all possible, construction of the landfill cell over significant residual contamination will be avoided. The exact siting of the landfill cell will be based on the results of surface soil sampling during the second unit RI, consideration of topography and hydrology of the site, and possibly additional geotechnical data collected during the RD. Sufficient land is available on which to site a landfill cell.

The sludge mound, main pit, and drum mound will be excavated. This represents a volume of approximately 180,000 cubic yards, and includes in excess of 10,000 to 20,000 unemptied drums. For this operable unit, the vertical extent of waste excavation will be to the upper surface of undisturbed bedrock (see Section 6.3 - Clean-up levels).


GRANULAR ACTIVATED CARBON FILTER
COLLECTION MANIFOLD
2% (MINIMUM)
3:1 (MAXIMUM)
2" NATURAL SOIL
GAS VENT
1" FILTER LAYER
6" GRANULAR LAYER
6" GAS VENTILATION LAYER
2" CLAY LINER
30 MIL SYNTHETIC LINERS
WASTE FILL
3:1 (MAXIMUM)
GRANULAR DRAIN MATERIAL
6" FILTER LAYER
DRAIN PIPES
6"
NATURAL SOIL OR FILL
3" LOW PERMEABILITY SOIL

NOT TO SCALE

FIGURE 6:

Typical cross-section of on-site landfill

Reproduced from best available copy.

After waste excavation, treatment, and disposal (described below), the empty waste pits and bedrock now underlying the waste piles will still remain. This upper bedrock surface is believed to be saturated with waste seepage to an unknown depth. Such residual contamination will generally not be removed during the source control remedial action, since the appropriate extent of vertical excavation cannot yet be defined. In order to prevent contamination of surface runoff waters and to eliminate direct contact exposure hazards from open areas of residual waste, it will be necessary to construct a protective temporary cap over the former source areas. This temporary cap will serve the dual purposes of preventing direct rainfall from leaching the contaminated bedrock and eliminating direct contact hazards. The cap will be constructed so as to achieve these goals and at the same time be of a design to allow upgrading to meet relevant and appropriate RCRA closure standards should it be determined by the second operable unit RI/FS that closure in-place is an appropriate permanent remedy for residual contamination beneath the former source areas. Considering the relative times required for design of the source control remedy and conduct of the management of migration RI/FS, it is possible that final clean-up levels will have been developed for the site prior to waste excavation. If such clean-up levels are available, the interim cap would be unnecessary and remedial action for residual contamination in the bedrock beneath the former source areas can proceed directly from excavation of the source areas.

Since wastes excavated in the source areas will range in consistency from dry solids to relatively pure liquids, and since the appropriate means of waste treatment and disposal is in large part determined by the physical consistency of the material, it is clear that criteria will have to be developed during the RD which allow segregation of: liquids for incineration or other treatment, solids whose moisture content is appropriate for landfilling, and solids requiring moisture reduction prior to landfilling.

Liquids will be defined by the relevant and appropriate RCRA testing procedures (currently the Paint Filter Test) which are effective at the time the remedial design is approved. Liquds will be segragated based on their chemical make-up (i.e. organic versus inorganic as described in the FS). The RD will develop criteria for making this distinction.

Solids, as defined by testing procedures noted in the above paragraph, will be handled in a manner based on decisions made in a moisture content evaluation, described below under Section 6.2.3. Based on the criteria developed there, wastes will have to have to fall below an upper limit on moisture content, after treatment, before they can be disposed in the landfill, provided other requirements, such as land disposal bans, do not preclude their placement in the landfill. Based on the determinations and criteria from the RD, the wastes will be treated and disposed as indicated in the general schematic shown in Figure 7. Discussion of waste treatment and disposal is provided below.

Treatment of organic liquids: These liquids will be incinerated. Based on the economics of the volume of materials encountered, this would be done either at an off-site facility or on-site with a portable or modular incinerator.

Treatment of inorganic liquids: Based on the economics of the volume and character of the liquids encountered, treatment and disposal may be done either on or off-site. On site treatment would generally be through physiochemical methods capable of removing both organics and metals, to allow discharge under an NPDES permit or transport to a publicly owned treatment works. If off-site treatment is selected, either deep well injection or treatment at a commercial facility would be available.

Treatment of Solids: Solids will ultimately be placed in the landfill cell constructed on-site. Prior to disposal, the wastes will be subjected to treatment aimed at reducing their toxicity and mobility. Since a large volume of contaminated soil is present, significant volume reduction would not be possible. Such treatment may include addition of materials to stabilize the fill or physiochemical treatment designed to remove or alter specific hazardous constituents or classes of compounds. Treatment technologies identified are:

- chemical neutralization (pH adjustment),
- solidification by addition of lime, cement, fly ash, or other proprietary agents,
- reduction of liquid content,
- chemical oxidation or reduction, and
- air stripping to remove volatiles.

Other alternative treatment technologies identified during the remedial design will also be considered for application, and those technologies showing promise for the specific wastes and situations at the Hardage site will be evaluated further through bench tests or pilot studies as appropriate

During the remedial design, an evaluation including bench testing will be conducted to determine an appropriate upper limit on the moisture content of fill which could be placed in the on-site landfill. This evaluation will consider the potential composition of pore fluids in the waste, the reaction of various soil/fluid combinations under the type of triaxial stresses to be expected within the

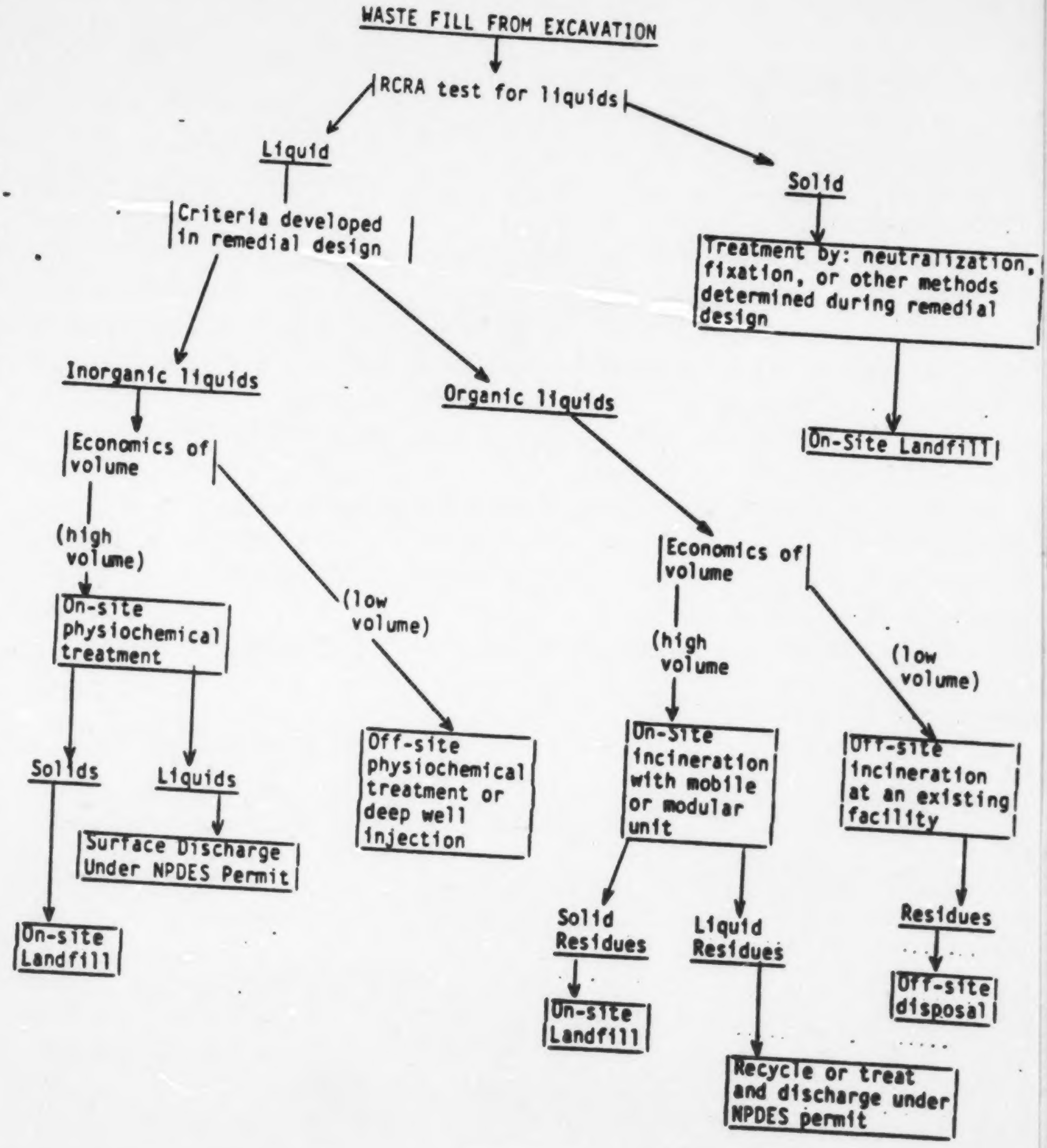

WASTE FILL FROM EXCAVATION
RCRA test for liquids
Liquid
Solid
Criteria developed in remedial design
Treatment by: neutralization, fixation, or other methods determined during remedial design
Inorganic liquids
Organic liquids
On-Site Landfill
Economics of volume
(high volume)
(low volume)
Economics of volume
On-site physiochemical treatment
(high volume
(low volume)
Off-site physiochemical treatment or deep well injection
On-Site incineration with mobile or modular unit
Off-site incineration at an existing facility
Solids
Liquids
Surface Discharge Under NPDES Permit
On-site Landfill
Solid Residues
Liquid Residues
Residues
On-site Landfill
Off-site disposal
Recycle or treat and discharge under NPDES permit

FIGURE 7: Treatment schematic for alternative number 7 - on-site landfill with liquids incineration

landfill, the potential for long and short-term leachate generation, and the effects of such leachate on various liner systems proposed for the landfill cell. Based on the results of this evaluation, an upper limit will be imposed on the moisture content of wastes which can be disposed in the landfill. Wastes placed in the landfill will in no case be of the type which:

a) would be classified as "liquids" by applicable or relevant and appropriate testing procedures pursuant to the RCRA prohibition on the disposal of liquids in landfills; or

b) are the subject of any land disposal bans under the Hazardous and Solid Waste Amendments to RCRA or the Toxic Substances Control Act which are determined to be applicable or relevant and appropriate.

Treatment technologies will be further refined during the RD phase; and additional design data may be required. The variability of wastes present in the source areas precludes any extensive characterization of wastes prior to excavation. For this reason, final determinations on appropriate treatment will in some cases have to be made during the RA itself.

6.3) Clean-up Levels for the Source Control Operable Unit:

Selection of clean-up levels will be a concern of the second operable unit (Management of Migration). Ultimately, clean-up levels will have to be selected for the base of the pits and for surface soils on-site. In the pit areas, the criteria will generally include potential for migration of metals and organics which have already migrated out of the pits. The surface soil criteria will focus on metals, PCBs, and pesticides due to their persistence in the environment, direct contact exposure hazards, and potential to contaminate surface runoff.

The Source Control operable unit deals exclusively with the concentrated pits and piles of wastes. In this case, selections of compounds of concern and selection of clean-up levels based on soil concentrations of these compounds is not appropriate. The criteria to be used for determining the extent of clean-up will be the surface of undisturbed bedrock. If, at that point in the RA, additional data from the second operable unit RI/FS or the Source Control RD has allowed determination of a final clean-up level, then excavation, in-situ treatment, or permanent capping may be implemented for the residual contaminants. If such data is not available, a temporary cap will be installed over the excavated areas pending second operable unit remedy determination.

6.4) Health and Safety Concerns During Implementation

Excavation of the waste piles and pits will pose hazards to workers via air and direct contact in addition to the physical hazards normally associated with such construction. In many cases the waste excavation and handling will have to be conducted under Level B protection (containerized air and protective clothing) to mimize hazards to the workers. Air release of volatile organics will likely increase during waste excavation. Continuous monitoring of air around working areas, at the site perimeter, and near offsite homes will allow identification of health threats to off-site residents and prevent problems from going undetected. Dust and vapor suppression measures, maintenance of a small working face of exposed waste, and possible use of a temporary structure over the excavation will help to minimize air releases.

Runoff retention structures and emergency holding ponds will be used to prevent chronic or sudden releases during construction.

7.0) COMPLIANCE OF REMEDIAL ACTION WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS FOR PROTECTION OF PUBLIC HEALTH AND THE ENVIRONMENT

Section 300.68(i) of the NCP directs that EPA will, except in narrow cases such as "fund-balancing", select a remedy that "attains or exceeds applicable or relevant and appropriate Federal public health and environmental requirements that have been identified for the specific site." These applicable or relevant and appropriate requirements (hereinafter "Requirements") are discussed in an October 2, 1985 memorandum from Winston Porter, Assistant Administrator for EPA's Office of Solid Waste and Emergency Response, "CERCLA Compliance with Other Environmental Statutes", which is set forth in the preamble to the NCP at 50 Fed. Reg. 47912, 47946 (November 20, 1985).

The principal requirements and policies to be considered during conduct of the RA will be as follows:

7.1) RCRA Subtitle C Permit Requirements, 40 CFR Part 264:

While not deemed applicable to the site since it closed prior to November 19, 1980, these requirements are considered to be relevant and appropriate to this CERCLA response action to the extent indicated below. Leaving engineering considerations aside, the Part 264 permit requirements are considered appropriate rather than the Part 265 interim status requirements. The facility closed prior to the effective date of interim status, rather than attempt to comply with these standards. Royal Hardage notified EPA of hazardous waste activity under RCRA in August 1980, but withdrew the notification in November 1980 and did not file Part A of the RCRA permit application, most likely because the site could not have met those standards without bankrupting the facility. As indicated previously, wastes were disposed haphazardly in unlined pits and the treatment, storage, and disposal of hazardous wastes at the facility as far below the standards required for interim status facilities. Indeed, EPA filed a lawsuit seeking clean up and closure of the facility under RCRA, Section 7003 in U.S. District Court in Oklahoma City on September 8, 1980. EPA has conclusive and demonstrable evidence of releases of hazardous wastes and hazardous substances from the disposal units of the Hardage site. Given this situation, the most appropriate Federal environmental requirements to apply to the source control action, which is consistent with and forms a substantial increment of a permanent site remedy, would be the Part 264 requirements, applicable to new facilities, along with their more stringent closure requirements.

Additionally, EPA believes that the physical nature of the site, it's hydrology, and underlying geologic conditions dictate that the waste materials not be left in-place. Accordingly, it is clear that the Part 264 permitting and closure requirements should be applied to the construction and closure of new disposal units necessary for this facility.

Finally, it should be noted that, as the preamble to the NCP states, "... although the Subtitle C regulations differ as to whether a hazardous waste facility has a RCRA permit (40 CFR Part 264) or is operating under interim status (40 CFR Part 265), remedies will generally have to be consistent with the more stringent Part 264 standards, even though a permitted facility is not involved. The Part 264 standards represent the ultimate RCRA compliance standards and are consistent with CERCLA's goals of long term protection of public health and welfare and environment." 50 Fed Reg at 47918.

7.1.1) Subpart B - Siting Requirements:

This will govern placement of the landfill cell on-site. The principal concerns stated in this subpart are seismic stability and flooding potential. Neither factor appears to be a major concern at the Hardage site; therefore, compliance does not seem to pose problems.

7.1.2) Subpart F - Groundwater:

This subpart will determine the extent to which the on-site landfill will be monitored. It will have a much wider application under the second operable unit.

7.1.3) Subpart G - Closure and Post-Closure:

These standards will apply to closure of the landfill cell(s) after completion of the source control RA. The remedy will comply with this subpart.

7.1.4) Subpart K - Surface Impoundments:

This will apply to any temporary impoundments constructed during the RA that treat, store,or dispose hazardous wastes. Impoundments will be lined, opearted, closed, and if necessary monitored in compliance with this subpart.

7.1.5) Subpart N - Landfills:

This subpart will govern construction and operation of the landfill cell. The landfill will meet requirements set forth for new landfills.

7.2) Toxic Substances Control Act:

This would come into application if PCBs are encountered at levels greater than 50 ppm, since such materials are banned from land disposal. In that case, alternative treatment would be required and implemented in order to comply with the Act.

7.3) EPA CERCLA Off-Site Policy (memorandum dated May 5, 1985; "Procedures for Planning and Implementing Off-site Response Actions"):

This policy will determine which TSD facilities are eligible for receipt of hazardous substances from the site. The policy generally requires a facility to be permitted and have no significant RCRA violations or conditions affecting it's satisfactory operation. Prior to disposing or authorizing disposal of wastes from this site the Region will contact the State in which the facility is located, review the facility's record of operation, and if appropriate contact other Regional offices of EPA where the facilities may be located to evaluate compliance with this policy. No wastes will be disposed at any site not meeting the criteria set forth in the policy.

7.4) Occupational Safety and Health Standards (29 CFR Part 1910):

These standards will be applied during remedial actions to protect workers from exposure to hazardous substances and other physical hazards associated with implementation of the RA. Methods for assuring the safety of workers involved in the RA will be devloped and described in a "Site Safety Plan" developed as part of the Remedial Design.

7.4) Hazardous and Solid Waste Amendments to RCRA of 1984:

The Hazardous and Solid Waste Amendments to RCRA of November 1984 (HSWA), 42 U.S.C. 6901 et seq. contain provisions setting several statutory dates for banning land disposal of hazardous wastes The provisions discussed here are RCRA Section 3004 (d)(e) and (g), due to the possible intersection of their statutory deadlines with the construction schedule for a source control remedy at the Hardage site.

The HSWA land disposal amendments are in fact not yet applicable or effective Federal requirements with respect to CERCLA Section 104 or 106 response actions, since their implementation dates are still some time off in the future. The bans found in subsection (g) are to be implemented during three periods over 21 months for 1/3, 2/3, and finally all of the RCRA subtitle C "listed" hazardous wastes commencing August 8, 1988, as determined by EPA. Those determinations will be made by rulemaking. See 50 Fed. Reg. 19300 (May 28, 1986) for the list of wastes to be considered.

The statutory ban on the "California List" wastes and solvents in subsections (d) and (e) and the prospective bans laws of subsection (g) are not considered relevant and appropriate at this time, since their applicability to CERCLA waste disposal is in the future. The effect of the bans in subsection (g) on the remedy is speculative at best, since EPA is required to engage in rulemaking for methods of land disposal and pretreatment for such disposal, 42 U.S.C. 6924 (g)(5) and (m). Futhermore, it must be emphasized that CERCLA requires the selection of cost-effective remedies and does not require EPA to implement standards that are not in effect.

During the course of remedial action and construction, EPA intends to further review the effect of land disposal bans on waste disposal at the site and the issues of how such laws will be implemented should they intersect the construction schedule. Additionally, bench tests and/or pilot studies may be performed with respect to pre-treatment methods for solvents and other organics potentially impacted by such bans.

8.0) OPERATION AND MAINTENANCE

The on-site landfill will require little routine operation and maintenance (O & M). Monitoring of the interior leachate detection system will be required, as will periodic inspections of the cap and monitoring of gases leaving the venting system. Development and routine sampling of a groundwater monitoring network will also be necessary for 30 years, at which time the need for additional monitoring will be reevaluated.

To provide a contingency in project cost estimates, it was assumed that at 30 years after construction replacement of the landfill liner and cap might be necessary. The cost is reflected in the present worth cost estimate of $70 million. Operation and maintanence costs on a present worth basis are estimated as $2,282,000 in 1985 dollars.

9.0) COMPLIANCE OF SOURCE CONTROL REMEDIAL ACTION WITH SECTION 121 OF THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT OF 1986 (SARA) TO THE MAXIMUM EXTENT PRACTICABLE

9.1) Basic Certification:

The selected remedy will comply with Section 121 of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended by SARA, including the cleanup standards thereof, to the maximum extent practicable. The selected remedy is considered to be cost effective and protective of human health and the environment as well, in accordance with the NCP.

9.2) Permanent Solutions and Technologies

In selecting this remedy, EPA has considered a full range of alternatives and solutions and alternative treatment technologies that will result in a permanent and significant decrease in toxicity, mobility, or volume of the hazardous substances present. In conducting its assessments of remedial alternatives and treatment technologies, EPA has considered:

1) The long term uncertainties of land disposal;

2) goals and requirements of the Solid Waste Disposal Act ("RCRA");

3) persistence, toxicity, mobility and bioaccumulation potential of the wastes;

4) short and long term potential for adverse human health effects;

5) long term maintenance costs of the remedy;

6) potential for future remedial actions costs if the remedy fails;

7) potential threat to human health and the environment from the excavation, transportation, and redisposal, or containment of hazardous substances.

9.3) Remedy Analysis:

The selected remedy is a remedy for the first operable unit of remediation - source control. It is a significant part of overall remediation at the Hardage site and is consistent with a permanent remedy for the site. The second operable unit, "management of migration", is now under development.

This remedy will employ treatment through incineration of all free liquid organics in the estimated 175,000 cubic yards of waste fill, as well as the more than 18,000 estimated drums of waste buried on-site. Remaining waste fill and inorganic solid drum contents will be treated through stabilization measures prior to redisposal in a double lined on-site RCRA compliant landfill cell. In carrying out these measures, EPA will be permanently and significantly reducing the volume, toxicity, and mobility of the hazardous substances present at the Hardage site. Further, EPA will avoid in large measure the potential dangers and uncertainties of transport and disposal off-site, with its on-site approach for the bulk of wastes. EPA requires that this source control remedy be reviewed not less than every five years to assure that human health and the environment are being protected.

As noted previously, in Section 7 herein, EPA has scrupulously considered the applicable or relevant and appropriate federal requirements for protection of public health and the environment in accordance with the NCP. EPA has also looked into the issue of applicable or relevant and appropriate state environmental laws and has determined that the "RCRA analogous" regulatory requirements of the Oklahoma Controlled Industrial Waste Disposal Act, as amended, authorized by EPA under RCRA to operate in lieu of the EPA regulations, are met or exceeded by the selected remedy. In a nutshell, EPA has complied with the SARA Section 121 cleanup standards to the maximum extent practicable.

10.0) OTHER OPERABLE UNITS

EPA's response actions on the Hardage/Criner have been divided into two operable units: Source Control (the remedy discussed in this document) and Management of Migration (also referred to as the groundwater/off-site operable unit).

The source control response is limited to the source areas of the site (sludge mound, main pit, and drum mound). The bases of the main pit and southern pit (beneath the sludge mound) at approximate elevations of 1109 and 1093 feet MSL respectively form the lower bound of the source areas. The lateral bounds of the source areas are described by the base of the slopes on the north, south, and west faces of the waste piles and pits, and as the lateral extent of the excavated pits on those sides of the source areas where wastes and cover have been backfilled to ground level.

The management of migration RI/FS will include the following:

- Definition of the extent and levels of contamination present in soils and rock outside the source area;
- determination of the extent and fate of groundwater contamination in the alluvium of North Criner Creek and the feasibility and need for remedial actions in the alluvial valley;

- determination of permanent surface clean-up levels on-site to prevent or minimize further degradation of potential surface and ground water supplies, direct contact hazards to the public, and other long term hazards.

11.0) ENFORCEMENT

11.1) Hardage I:

In 1979, EPA inspections of the site indicated poor waste management practices posing potential threats to public health and welfare and the environment. In September 1980, the U.S. Department of Justice (DOJ) filed a complaint on behalf of EPA in U.S. District Court in Oklahoma City, Oklahoma. The complaint alleged violations of Section 7003 of RCRA and sought proper cleanup and closure of the site. The facility had ceased operations in early November 1980, before RCRA Interim Status Standards came into effect.

In 1982, DOJ and EPA amended the existing complaint against the facility owner and operator Royal Hardage. The complaint was changed to include allegations and requested relief under Sections 106 and 107 of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA). In December 1982, the Court found that the site posed an imminent and substantial endangerment to public health and welfare and the environment as defined by CERCLA Section 106 and RCRA Section 7003. In August 1983, the Court granted a partial judgment for over $211,000 in response costs, which EPA had incurred through 1982, against Royal Hardage.

Hardage filed for bankruptcy in 1983 and again in 1985, and EPA has never recovered its partial judgment.

11.2) Hardage II

EPA compiled available records from the sites operations including daily and monthly site logs of wastes received, waste manifests, and disposal plans and records filed with the State of Oklahoma by generators and transporters of waste to the site.

As a result numerous Potentially Responsible Parties (PRPs) were identified. In December 1984, EPA mailed letters to 289 of these PRPs requesting information about their waste disposal at the Hardage site under authority of Section 104(e) of CERCLA and Section 3007 of RCRA and notifying the PRPs of their potential liability for site cleanup. As further information was gained, information request and notice letters were sent to additional PRPs identified. At the present time, over 400 PRPs have been identified. Various PRPs have gone out of business or cannot be located; therefore, approximately [illegible]40 have been contacted. A number of these parties, have organized into the Hardage Steering Committee (HSC). The HSC has met with EPA and OSDH on numerous occasions since EPA's first PRP meeting concerning the site in January 1985.

Since the FS was on going at the time the PRPs were notified and CERCLA progam policy previously did not allow PRP conduct of RI/FS studies without a signed agreement to also implement the EPA selected remedy, the PRPs were not involved in preparation of the FS. In May 1985, EPA released the DSR documenting 1984 site investigations: and HSC also obtained all EPA files on the site. The HSC has retained Dames & Moore and more recently ERM-Southwest to provide technical support in their dealings with EPA.

In July 1985 the Court administratively closed the 1980 case against Hardage, providing that the U.S. could re-open the case for the purpose of seeking appropriate relief until April 1, 1986, at which time the case would otherwise be dismissed. DOJ, on behalf of EPA, filed a motion on March 27, 1986, to amend the existing complaint and add generators and transporters to the existing case. The Court ultimately denied the motion and dismissed the case, providing that Royal Hardage could be named for limited purposes in a subsequent case.

On June 25, 1986, DOJ filed a new complaint naming 36 generators and transporters of waste at the site. The complaint asks for performance of the EPA selected source control remedy, maintenance of site security, conduct of a RI/FS for the management of migration operable unit and any subsequent EPA selected remedy, and recovery of EPAs' past and future response costs. A status conference was held on September 3, 1986, and a second status conference has been set for January 7, 1987.

12.0) COMMUNITY INVOLVEMENT

Due to the large number of PRPs for this site, the majority of meetings, comments on the FS, and other external communication has been with these parties, However, attention has been given to the concerns of near site residents and other interested parties.

When the draft FS was completed on February 20, 1986, a press release was issued announcing this fact, copies of the FS were placed in repositories, and a copy was provided directly to the Hardage Steering Committee. The public comment period was from March 10-April 15, 1986. A public meeting was held in Chickasha, Oklahoma to answer questions and receive comments on the FS on March 20. The response to questions, comments, and concerns raised during this period is contained in the Responsiveness Summary, Appendix C.

13.0 REFERENCES

CH_2M Hill 1985

Field Investigation and Data Summary Report, Royal Hardage Industrial Hazardous Waste Site, CH_2M Hill, May 22, 1985

CH_2M Hill 1986a

Preliminary Public Health Assessment, CH_2M Hill, August 1986

CH_2M Hill 1986b

Source Control Feasibility Study, Royal Hardage Industrial Hazardous Waste Site, CH_2M Hill, February 20, 1986

EPA 1985a

Public Health Assessment Manual, EPA - Office of Solid Waste and Emergency Response, November 1985

EPA 1985b

Guidance on Feasibility Studies Under CERCLA, EPA, June 1985

EPA 1986

Superfund Remedial Design and Remedial Action Guidance, EPA, June 1986

Eltex 1985

Letter from Eltex Chemical and Supply (Houston, Texas) to Stephen Phillips (EPA-Dallas), August 1985

Hardage 1972-80

Monthly waste site log of materials received at the Hardage site

Kent 1982

Evaluation of Hydrogeology at Royal Hardage Industrial Waste Site; Criner, Oklahoma, Douglas C. Kent, May 1983

OSDH 1972

Industrial-Hazardous waste landfill permit issued September 12, 1972 to Royal HJartdage by OSDH

USGS 1966

Base of Fresh Groundwater in Southern Oklahoma, D.L. Hart, United States Geological Survey Hydrologic Atlas - 223, 1974

APPENDIX A

CHRONOLOGY OF EPA SITE INVESTIGATIONS PRIOR TO 1984

APPENDIX A

EPA Sampling and Inspections of Hardage/Criner prior to 1984:

June 27, 1979

Inspector: Ralph Hawkins (EPA-Ada Branch) accompanied by Oklahoma State and County Health Department personnel

Purpose: NESHAPS inspection due to asbestos disposal

Result: Recommended Sampling of site

Documentation: 7/3/79 memo, Hawkins to Charles Gazda (EPA-Dallas)

August 15, 1979

Inspector: S.C. Yin (EPA - Ada Branch) with other EPA and State Health Department personnel

Purpose: Obtain samples and inspect site

Result: Nine soil, water, and waste samples taken, analyzed for metals and organics; photos taken

Documentation: 9/10/79 memo, Yin to Charles Gazda (EPA-Dallas) 10/26/79 memo William Langley (EPA-Houston Lab) to Oscar Ramirez (EPA-Dallas) transmitting analytical results.

August 14, 1980

Inspector: Thomas Smith of Ecology & Environment (FIT) for EPA

Purpose: Off-Site sampling

Result: Three samples taken from off-site drainage pathways; analyzed for metals and organis; photos taken

Documentation: 8/21/80 memo T. Smith to Charles Gazda (EPA-Dallas); 9/23/80 memo William Langley (EPA-Houston Lab) to William Librizzi (EPA-Dallas) transmitting analytical results

October 1, 1980

Inspector: S.C. Yin (EPA-Ada Branch) with FIT personnel

Purpose: Off-site sampling

Result: Thirteen (13) samples taken from off-site drainage and domestic water wells, analysis for metals and organics, photos taken

Documentation: 10/23/80 memo, Yin to William Librizzi (EPA-Dallas): 10/15/80 memo William Langley (EPA-Houston Lab) to Librizzi transmitting analytical results

March 23 - April 8, 1982

Inspector: Imre Sekelyhidi (FIT) personnel and other FIT employees for EPA

Purpose: Detailed on and off-site sampling of the site

Result: 3/23-24/82, 29 samples collected;
3/30-4/1/82, 6 domestic wells sampled
3/30-4/2/82, 10 monitoring wells drilled, by Shepard Testing and Engineering Co., Inc. of Norman, Oklahoma at locations directed by Jerry Thornhill (Hydrogeologist, EPA-Ada Branch)
soil borings and monitoring well samples collected from each new monitoring well

August 16, 1982

Inspector: Ecology & Environment (FIT) for EPA

Purpose: Second sampling round for the wells drilled by FIT in March 1982

Result: 10 groundwater samples collected

APPENDIX B

LIST OF POTENTIALLY RESPONSIBLE PARTIES IDENTIFIED FOR THE HARDAGE/CRINER SITE

CORP.
710 A BETTER SANITATION
711 ABLE UNIFORM RENTAL
712 ACME FENCE
713 ADVANCE PACKAGING
714 AGLAND, INCORPORATED
715 ALTEC SOUND PRODUCTS DIVISION
716 AMERICAN AIRLINES, INCORPORATED
717 AMERICAN DISPOSAL SERVICE
718 AMERICAN FARM LINES, INCORPORATED
719 AMERICAN FURNITURE STRIPPING
720 AMERICAN TRAILERS, INCORPORATED
721 AMOCO PRODUCTION COMPANY & RESEARCH
722 A-ONE BIT & TOOL COMPANY
723 ATLANTIC RICHFIELD COMPANY
724 ARKANSAS BEST CORPORATION
725 ARROW TANK TRUCK, INCORPORATED
726 ARTHUR G. McGEE AND COMPANY
727 ASHLAND CHEMICAL COMPANY
728 BALON CORPORATION
729 BEAUTY CRAFT TILE OF THE SOUTHWEST, INC.
731 BINNEY I. SMITH, INCORPORATED
732 BOB MOORE OILWELL SERVICE
733 BORDEN CHEMICAL DIVISION
734 BRITTAIN BROTHERS (NAPA)
735 BROADWAY MACHINE & MOTOR SUPPLY
736 BROWN AND ROOT, INCORPORATED
737 BROWNING-FERRIS INDUSTRIES, INCORPORATED
738 B.S. & S. ENGINEERING COMPANY
739 CAPITOL GREASE COMPANY
740 CATO OIL & GREASE
741 C.E. NATCO
742 CHARLES MACHINE WORKS, INCORPORATED
743 CHROM ALLOY DIVISION
744 CHROMIUM PLATING COMPANY
745 CIMARRON MANUFACTURING COMPANY
746 CITIES SERVICE OIL COMPANY
747 CITY SERVICE
748 CITY OF NORMAN
749 CLAYTON PLATING COMPANY
750 CLYDE'S CARBURETOR SERVICE
751 CMI CORPORATION
752 COMPETITION AUTOMOTIVE
753 CONOCO, INCORPORATED
754 CONSOLIDATED CLEANING SERVICE COMPANY
755 CONTAINER CORPORATION OF AMERICA
756 CORE LABORATORIES
757 COUNTY HOME MEAT COMPANY
758 CRANE CARRIER CORPORATION
759 BROSBY GROUP, McKISSICK PRODUCTS DIV.
760 CROWL MACHINE & HEAT TREATING
761 CROWN TRANSPORT COMPANY
762 DAL-WORTH INDUSTRY, INCORPORATED
763 DAYTON TIRE & RUBBER COMPANY
764 DEL PAINT MANUFACTURING
765 DELTA FAUCET COMPANY
766 DELTA TRANSMISSION

THIS LIST REPRESENTS EPA'S PRELIMINARY FINDINGS ON THE IDENTITIES OF POTENTIALLY RESPONSIBLE PARTIES. INCLUSION ON THIS LIST DOES NOT CONSTITUTE A FINAL DETEMINATION CONCERNING THE LIABILITY OF ANY PARTY FOR THE HAZARD OR CONTAMINATION AT THE HARDAGE SITE

DESOTA, INCORPORATED
769 DESOTA, INCORPORATED
770 DOUBLE EAGLE REFINING LUBRICANTS, INC.
771 DOVER CORPORATION
772 DOW CHEMICAL COMPANY
773 DOWNTOWN AIRPARK, INCORPORATED
774 DRILLERS ENGINE & SUPPLY
775 DURA-CHROME INDUSTRY
776 EASON & SMITH, WASTE HAULERS
777 EASON ENTERPRISES
778 EASON OIL
779 E.I. DUPONT DE NEMOURS
780 ELTEX CHEMICAL AND SUPPLY COMPANY
781 ENGINEERING ENTERPRISES
782 EQUIPMENT RENEWAL COMPANY
783 ERNEST ST. CLAIR
784 EUREKA TOOL COMPANY
785 EVAN'S ELECTRIC SERVICE CENTER
786 FAA AERONAUTICAL CENTER
787 FIBERCAST CORPORATION
788 FINE CANDY COMPANY
789 FIRST NATIONAL MANAGEMENT CORPORATION
790 FLINT STEEL CORPORATION
791 FORD GLASS PLANT
792 FOSTER FEED & SEED
793 FOSTER SEPTIC TANK CLEANING
794 FRED JONES MANUFACTURING
795 FRUEHAUF CORPORATION
796 GARDNER-DENVER COMPANY
797 GENERAL ELECTRIC
798 GENERAL ELECTRIC
799 GENERAL TIRE & RUBBER
800 GEOPHYSICAL RESEARCH
801 GLIDDEN COATINGS & RESINS COMPANY
802 GLOW-LITE DIVISION OF DUTCH BOY, INC.
803 GOODYEAR TIRE & RUBBER COMPANY
804 GOVERNAIR CORPORATION
805 GROENDYKE TRANSPORT, INCORPORATED
806 HALLIBURTON SERVICES
807 ROYAL M. HARDAGE
808 HART INDUSTRIAL DISPOSAL
809 HATHAWAY INDUSTRIES
810 HELM & WEAVER
811 HERMETIC SWITCH, INCORPORATED
812 HOLLEY CARBURETOR
813 INDUSTRIAL UNIFORM
814 INDUSTRIAL DISPOSAL SUPPLY, INCORPORATED
815 INTERNATIONAL CRYSTAL MANUFACTURING
816 JOHN ZINK COMPANY
817 JONES-BLAIR PAINT COMPANY
818 KELSEY-HAYES
819 KELTRONICS CORPORATION
820 KERR McGEE, PRESIDENT
821 KIMBALL CHEMICAL COMPANY
822 KOBE INCORPORATED
823 KOCO TV
824 LAWT PLATING COMPANY
825 LEAF SIEGLER, INCORPORATED

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826 L. & S. BEARING COMPANY
827 LEEWAY MOTOR FREIGHT(C.L. MOTOR FREIGHT)
828 MAREMONT CORPORATION
830 MASTER MOTORS
831 MATERIALS RECOVERY ENTERPRISES
832 McDONNELL DOUGLAS
833 McKESSON CHEMICAL COMPANY
834 MANUFACTURING MERCURY MARINE
835 METROPLEX SANITATION
836 MIKE MONRONEY AERONAUTICAL
837 MOBIL CHEMICAL COMPANY
838 NAMEPLATES, INCORPORATED
839 NATIONAL CAN CORPORATION
840 NATIONAL PACKAGING COMPANY
841 NELSON ELECTRIC COMPANY
842 NEWSPAPER PRINTING CORPORATION
843 NICKLES MACHINE CORPORATION
844 NORDHAM, INCORPORATED
845 NORTHROP WORLDWIDE AIRCRAFT SERVICE INC.
846 NU CHROME PLATING
847 O'BRIEN PAINT CORPORATION
848 OCCIDENTAL CHEMICAL
849 OKLAHOMA CITY DISPOSAL
850 OKLAHOMA GAS & ELECTRIC
851 OKLAHOMA CITY COUNTY HEALTH DEPARTMENT
852 OKLAHOMA DEPARTMENT OF AGRICULTURE
853 OKLAHOMA DEPARTMENT OF CORRECTION
854 OKLAHOMA STATE DEPARTMENT OF HEALTH
855 O.K. PUBLISHING COMPANY
856 OKLAHOMA MACHINE MANUFACTURING
857 O.K. NATIONAL STOCKYARDS COMPANY
858 O.K. NATURAL GAS COMPANY
859 O.K. TANK SERVICE, INCORPORATED
860 O.K. TRANSPORTATION COMPANY
861 ORAL ROBERTS UNIVERSITY
862 PAGE INDUSTRIES
863 PATTERSON SARGENT
864 PHARMASEAL LABS
865 PHILLIPS CHEMICAL
866 PHILLIPS PETROLEUM
867 POWELL SANITATION SERVICE
868 POWELL SERVICE COMPANY
869 PRESBYTERIAN HOSPITAL
870 PRESTOLITE CORPORATION
871 PRYOR FOUNDRY, INCORPORATED
872 PUBLIC SERVICE COMPANY
873 RA NAJ CIRCUITS, INCORPORATED
874 RANDY ALLID
875 REAGENT CHEMICAL & RESEARCH, INC.
876 RED BALL MOTOR FREIGHT
877 ROCKWELL INTERNATIONAL
878 ROCKWELL INTERNATIONAL CORPORATION
879 RODCC INCORPORATED
880 ROTEX CORPORATION
881 ST. A THONY HOSPITAL
882 S.&S. LATING COMPANY
883 SANTA E RAILROAD

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884 SCA SERVICES
885 SEARS AUTO CENTER
886 SENTRY MANUFACTURING
887 SERMETEL, INCORPORATED
888 SERVICE PAINT MANUFACTURING COMPANY
889 SHAKLEE CORPORATION
890 SHERWIN-WILLIAM COMPANY
891 SKY WITCH
892 SOLVENT MANUFACTURING COMPANY, INC.
893 SOONER FORD
894 SOONER OIL PATCH SERVICES, INCORPORATED
895 SOUTHERN HILLS COUNTRY CLUB
896 SOUTH PRAIRIE CONSTRUCTION
897 SOUTHWEST ELECTRIC COMPANY
898 SOUTHWESTERN STEEL ROLLING DOOR COMPANY
899 SOUTHWEST UNITED INDUSTRIES
900 SPERRY VICKER COMPANY
901 STAN RAMSEY COMPANY, INCORPORATED
902 STANDARD CHEMICAL COMPANY
903 STAR MANUFACTURING COMPANY
904 STEELCRAFT, INCORPORATED
905 STORM PLASTICS, INCORPORATED
906 SUBLETT & ASSOCIATES
907 SUN GAS
908 TEXACO, INCORPORATED
909 TEXAS INSTRUMENTS
910 TEX PRODUCTS, INCORPORATED
911 THE BUCKET SHOP, INCORPORATED
912 SAMUEL ROBERTS NOBLE FOUNDATION, INC.
913 THOMAS & BETTS
914 THOMPSON HAYWARD CHEMICAL COMPANY
915 UNITED STATES AIR FORCE
916 TRIBONETICS COMPANY
917 TOM BROWN'S OPTICAL
918 TOX
919 TRIGG DRILLING
920 TUFTS & SON OF OKLAHOMA
921 UNARCO COMMERCIAL PRODUCT
922 UNIROYAL TIRE COMPANY
923 UNIT PARTS, BORG-WARNER COMPANY
924 UNITED FOAM
925 UNITED PLATING WORKS, INCORPORATED
926 UNIVERSAL OIL PRODUCTS
927 UNIVERSITY OF OKLAHOMA
928 UNIVERSITY OF OKLAHOMA
929 UNIV. OF OKLAHOMA HEALTH SCIENCE CENTER
930 UNIVERSITY OF OKLAHOMA
931 COLONEL MARY FELTS
932 U.S. CORPS OF ENGINEERS
933 U.S. DEPARTMENT OF ENERGY
934 U.S. POLLUTION CONTROL
935 U.S. POLLUTION CONTROL
936 VETERANS ADMINISTRATION
937 WAYNE CIRCUIT
938 WELCH OIL COMPANY
939 WESTERN ELECTRIC COMPANY
940 WESTERN EXTRACT MANUFACTURING COMPANY

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941 WESTINGHOUSE ELECTRIC CORPORATION
942 WEYERHAEUSER COMPANY
943 WILSON DOWNHOLE SERVICES
944 W.J. LAMBERTON
945 WOLVERINE PIPE
946 ZOECON INDUSTRIES
947 OKLAHOMA GRAPHICS
948 U.S. SMALL BUSINESS ADMINISTRATION
949 GENERAL MOTORS
950 SUPERIOR LINEN
951 O.K. MEMORIAL HOSPITAL
952 JIM'S SEPTIC SERVICES
953 A-A EMERGENCY PLUMBING
954 RIVERSIDE INDUSTRIES
955 WASTE MANAGEMENT
956 INTERNATIONAL SYSTEM & CONTROL
957 P.A. INDUSTRIES-POLAR MANUFACTURING
958 AMAX, INCORPORATED
959 WASTE MANAGEMENT, INCORPORATED
960 SANDTRAP SERVICE
961 FOSTER FEED & SEED COMPANY
962 JOC OIL EXPLORATION COMPANY, INC.
963 ALLIED PAINT CORPORATION
964 BORG-WARNER CORPORATION
965 CLIFTCO, INCORPORATED
966 HONEYWELL COMPANY
967 COOK PAINT AND VARNISH COMPANY
968 CHEMICAL LEAMAN TANK LINES, INCORPORATED
969 DIAMOND PAINT COMPANY
970 EXXON CHEMICAL COMPANY
971 W.R. GRACE & COMPANY
972 GULF STATES PAINT COMPANY
973 RALPH LOWE
974 MAGNA CORPORATION
975 NALCO CHEMICAL COMPANY
976 THE O'BRIEN CORPORATION
977 P.P.G. INDUSTRIES
978 RELIANCE UNIVERSAL, INCORPORATED
979 ROHM AND HAAS TEXAS, INCORPORATED
980 WITCO CHEMICAL COMPANY
981 TRIANGLE ENGINEERING COMPANY

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APPENDIX C

COMMUNITY RELATIONS RESPONSIVNESS SUMMARY ON THE SOURCE CONTROL FEASIBILITY STUDY

COMMUNITY RELATIONS RESPONSIVENESS SUMMARY
ON THE SOURCE CONTROL FEASIBILITY STUDY

HARDAGE/CRINER SUPERFUND SITE
MCCLAIN COUNTY, OKLAHOMA

NOVEMBER 1986